

SERVICE MANUAL
MODEL C64 COMPUTER
MARCH 1985 PN-314001-02



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CONTENTS

Title	Page
SPECIFICATIONS	1
PRODUCT PARTS LIST	2
BLOCK DIAGRAM	3
CIRCUIT THEORY	
POWER SUPPLY	4
RESET LOGIC	5
CLOCK CIRCUITS	6
I/O, ROM, EXPANSION PORT	7
RAM CONTROL LOGIC	8
5 PIN VIDEO AND AUDIO OUTPUTS	9
8 PIN VIDEO AND AUDIO OUTPUTS	10
CASSETTE INTERFACE	11
KEYBOARD, JOYSTICK & PADDLE INTERFACES	12
SERIAL INTERFACE, USER PORT	13
TROUBLESHOOTING GUIDE	14
BOARD IDENTIFICATION	17
PCB ASSEMBLY #326298-01	
BOARD LAYOUT	18
PARTS LISTS	19,20
PIN ASSIGNMENTS	21
SCHEMATIC #326106	21,22
PCB ASSEMBLY #250407-04	
BOARD LAYOUT	23
PARTS LIST	24,25
MODULATOR SCHEMATIC #251025	26
SCHEMATIC #251138	26,27
PIN ASSIGNMENTS	27
PCB ASSEMBLY #250425-01	
BOARD LAYOUT	28
PARTS LIST	29,30
MODULATOR SCHEMATIC #251696	31
SCHEMATIC #251469	31,32
PIN ASSIGNMENTS	32

C64

COMPUTER

GENERAL DESCRIPTION

- The "All Purpose" Commodore 64 is the complete computer for education, home or small business applications. Supported by quality peripherals and a full range of software, the Commodore 64 is perfect for the family. No other computer can offer such variety of uses and applications at such an affordable price.

MEMORY

- 64K RAM

ROM

- 20K ROM Standard (includes operating system and BASIC interpreter)

MICROPROCESSOR

- 6510A Microprocessor—1.02 MHz clock
- Compatible with the 6502

DISPLAY

- 40 Columns X 25 lines of text

COLORS

- 16 Background, border and character colors

CHARACTERS

- Upper & lower case letters, numerals and symbols
- Reverse characters
- All PET graphic characters

DISPLAY MODES

- Text characters
- High resolution graphics

RESOLUTION

- 320 X 200 Pixels

SPRITES

- 8 independent sprites
- Each consists of 24 X 21 pixels and up to 4 colors
- Each independently expandable horizontally and vertically
- Collision detection for sprite to sprite and data to sprite collisions

SOUND

- 6581 Sound Interface Device includes 3 independent tone generators—each with 9 octaves
- Each voice includes programmable ADSR generator (Attack, Decay, Sustain, Release) and control of sawtooth, triangle, square, variable pulse and noise waveforms
- Full filtering capabilities with low, high and band pass filters
- External sound input

KEYBOARD

- Full size typewriter style design

KEYS

- 66 Keys total
- 2 Cursor control keys
- 4 Function keys (up to 8 user defined/programmable functions possible)
- Upper and lower case character set
- Graphic character set

INPUTS/OUTPUTS

- User port
- Serial port
- ROM cartridge port
- 2 Joystick/paddle ports
- Video port
- C1530 Cassette drive interface port

FEATURES

- Built-in BASIC 2.0—over 70 commands, statements and functions
- Full screen editor

PERIPHERALS

- C1541 Disk drive
- C1530 Datasette
- MPS 801 Dot matrix printer
- MPS 802 Dot matrix printer
- MPS 803 Dot matrix printer
- DPS 1101 Daisey wheel printer
- C1520 Plotter/Printer
- C1702 Color monitor
- CM141 Color monitor

POWER REQUIREMENTS

- 120 Volts, 60 Hz

Specifications subject to change without notice.

PARTS LIST

C-64

PLEASE NOTE: Commodore part numbers are provided for reference only and do not indicate the availability of parts from Commodore. Industry standard parts (Resistors, Capacitors, Connectors) should be secured locally. Approved cross-references for TTL chips, Transistors, etc. will be available in manual form through the Service Department in November of 1984. Unique or non-standard parts will be stocked by Commodore and are indicated on the parts list by a "C".

TOP CASE ASSY

Top Case	C 326113-01
Keyboard	C 326166-02
LED Plate	C 326160-01
Nameplate	C 326161-01
Lamp Holder Set	C 903820-03
LED Assembly	C 1001039-01

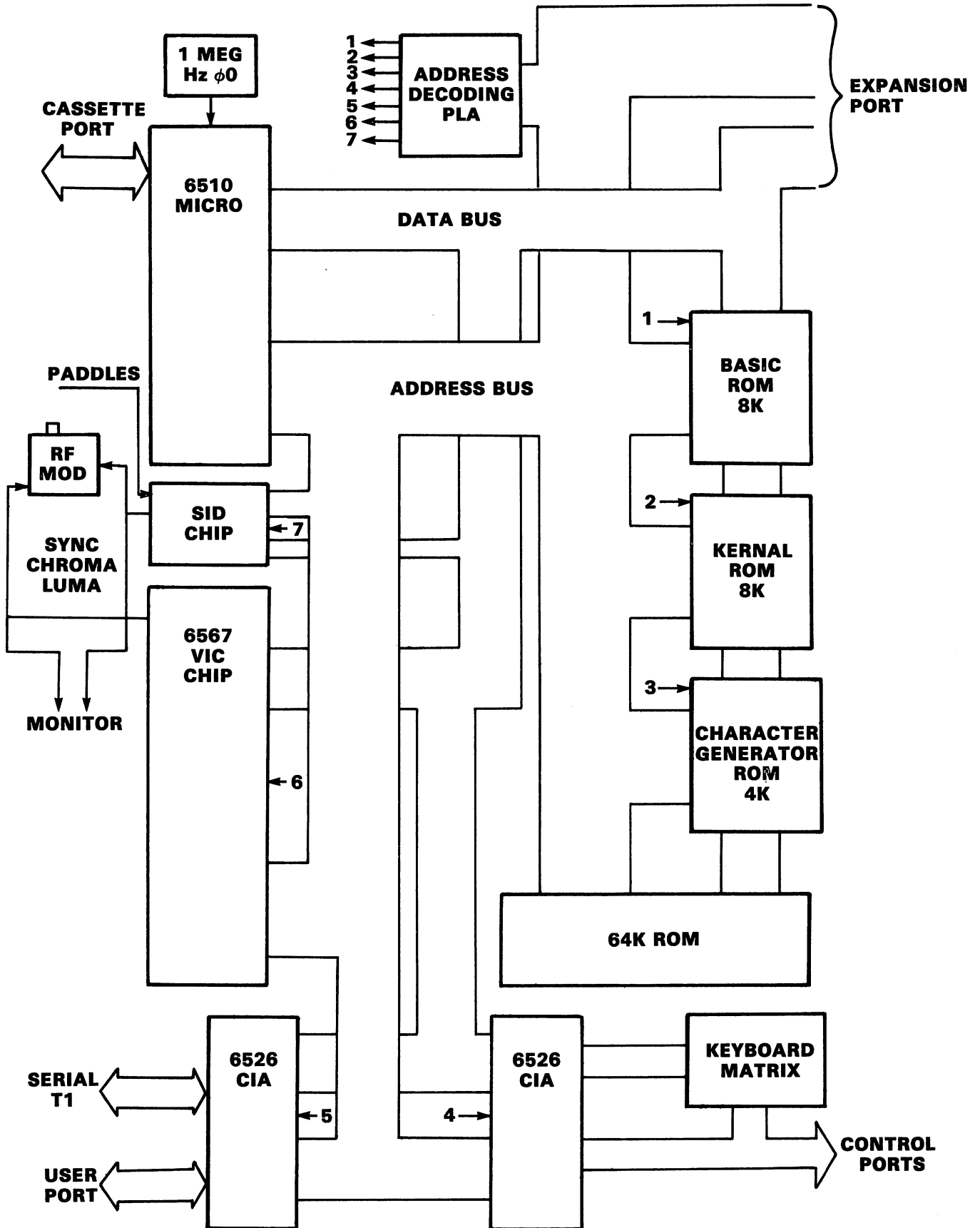
BOTTOM CASE ASSY

Bottom Case	C 326114-01
Foot, Self-Adhesive	C 950157-04
PCB Shield Plate	C 326131-01
PCB Insulation Sheet	C 326288-01

ACCESSORIES

Users Manual	C 320974
Power Supply	C 251053-02
RF Cable	C 326189-01
Switch Box	C 904778-01

C-64 BLOCK DIAGRAM



C64 CIRCUIT THEORY

There are three versions of the C64. The C64 with a five pin connector video output (326106), The C64 with an eight pin connector video output (251138), and the C64B which has improved system clock circuit design (251469). Most circuit theory explanations will be the same for all three versions. Refer to schematic 326106 unless noted otherwise.

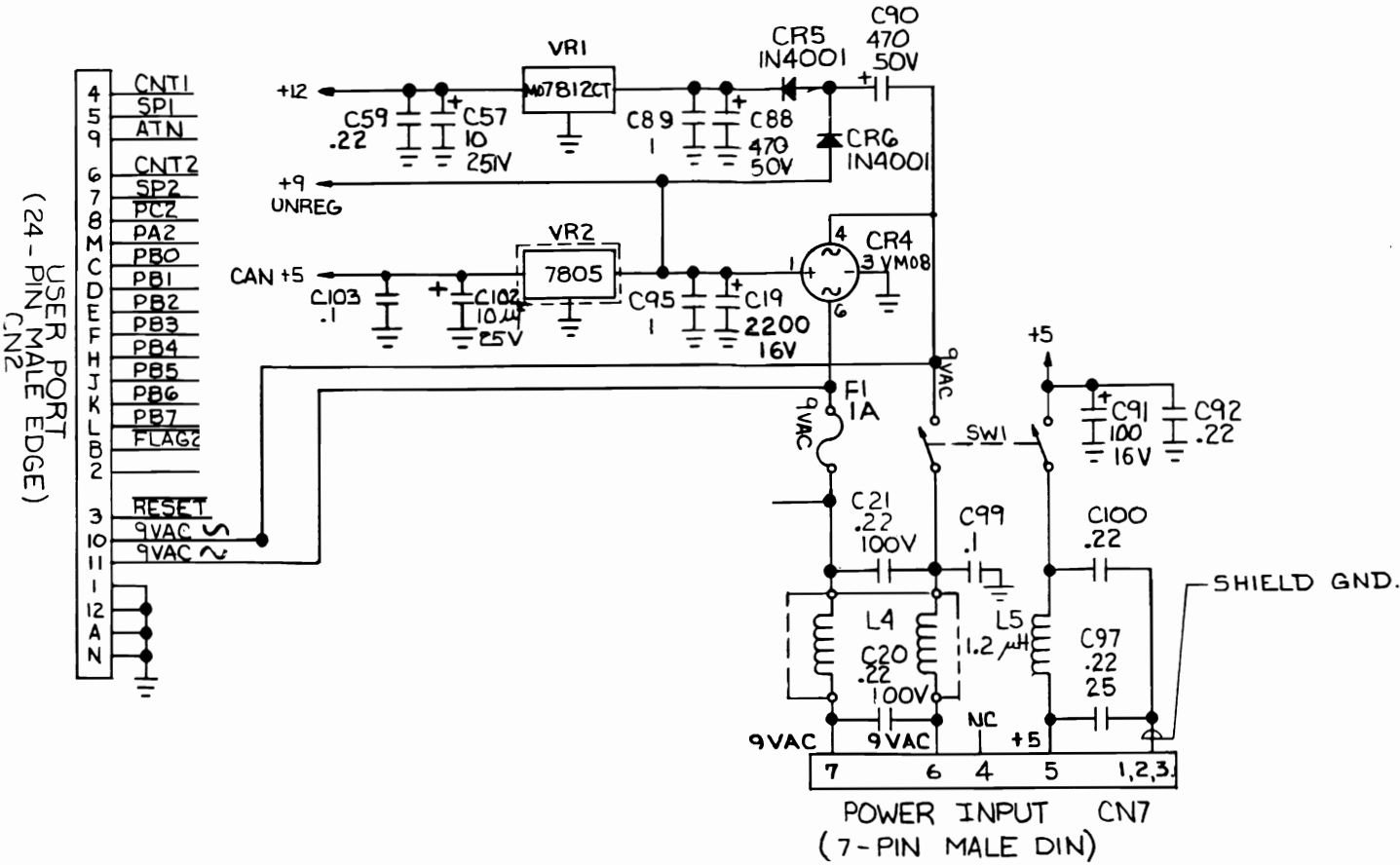
The Power Supply.

The external power supply generates a regulated 5VDC and 9VAC. 5VDC is applied to pins 5 and 1 of CN7 on the C64 pcb. Filtered by L5,C97, and C100 it is then controlled by on/off switch S1. This 5VDC output supplies the microprocessor logic.

9VAC is applied to pins 6 and 7 of CN7 on the C64 pcb. +12VDC, +5VDC CAN and 9VDC unregulated are outputs that are derived from this 9VAC supply. The 9VAC supply is made available on pins 10 and 11 of the USER PORT CN2.

12VDC Generation

9VAC is added to 9VDC through CR6, and rectified by CR5. The unregulated DC output is filtered by C88 and C89 then regulated at 12VDC by VR1. The regulated output is filtered by C57 and C59. The 12VDC supplies the VIC and SID IC, and the audio amplifiers.

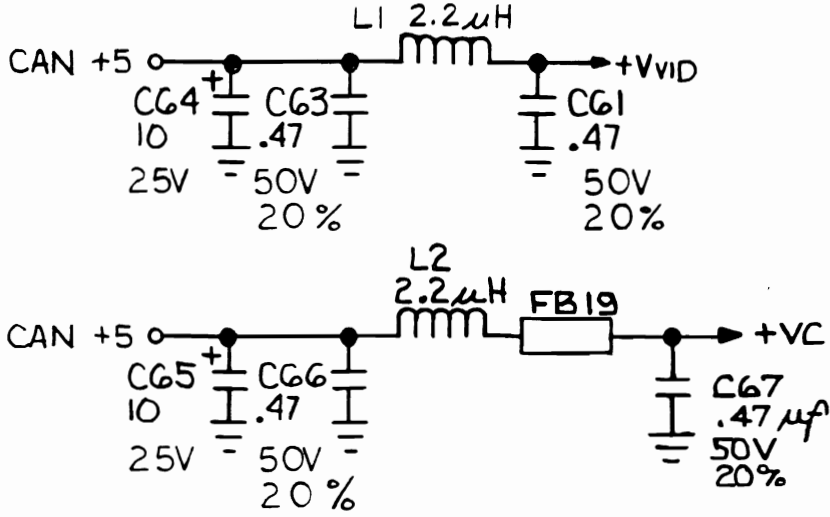


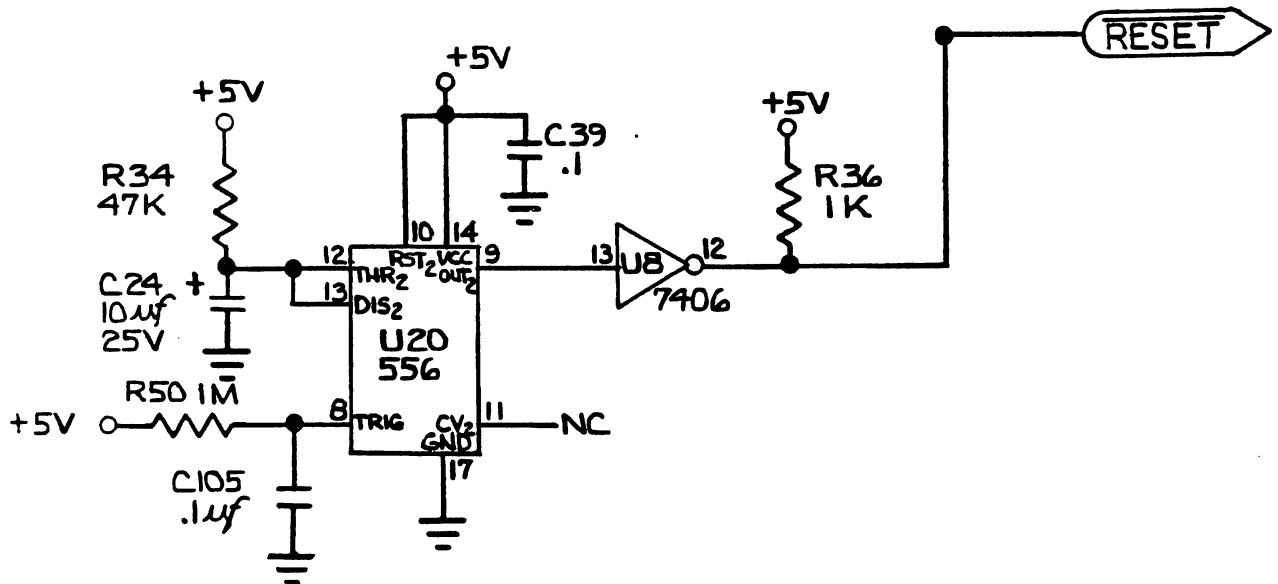
+5VDC CAN Generation

9VAC is rectified by CR4. The unregulated DC output is filtered by C19, and C95 then regulated at 5VDC by VR2. The regulated output is filtered by C102 and C103. The output called 5VDC CAN is separated and individually filtered into two outputs called Vvid and Vc. Vvid is the 5VDC supply for the video circuits, and Vc is the 5VDC supply for the clock circuits.

9VDC Unregulated Generation.

CR4 rectifies the 9VAC input. The output is 9VDC unregulated. This supply powers the cassette motor transistor amplifier circuits, and the RF modulator on the C64B version.

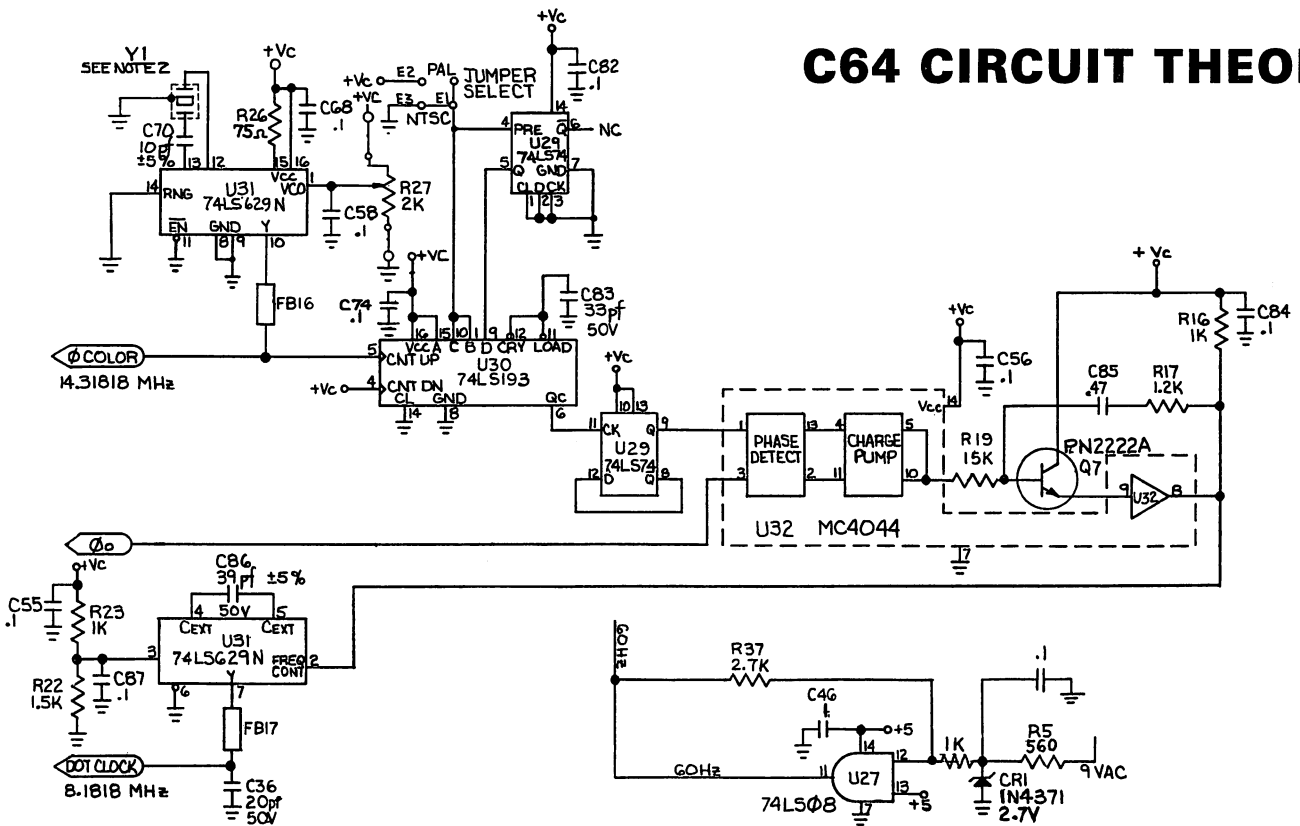




Reset Logic Circuits.

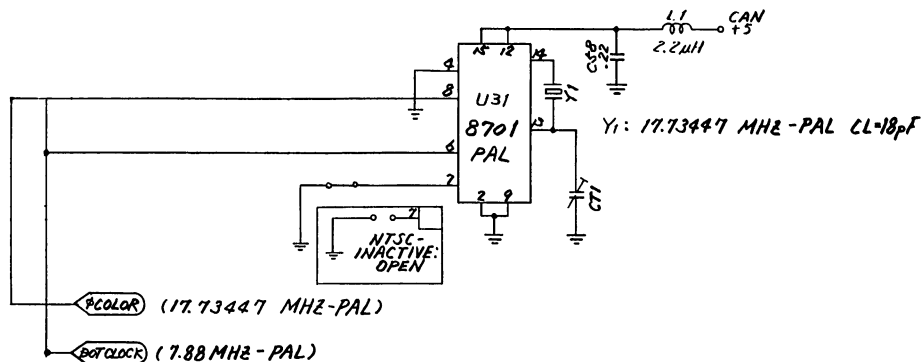
U20 is a 556 IC timer configured as a one shot multivibrator. The output pulse width is determined by the size of R34 and C24. Pulse width = $1.1 \times R34 \times C24 \approx .5$ seconds. The output on pin 9 is "high" active. The output of U8 is "low" active. Reset initializes all the processor logic and causes the processor to load the program counter register with the address of the first instruction of the operating system program called the KERNAL. The starting address is stored in locations \$FFFC and \$FFFD. The first instruction is decoded and executed giving KERNAL control of the computer operations. The reset pulse occurs when turning the power on to the computer.

C64 CIRCUIT THEORY



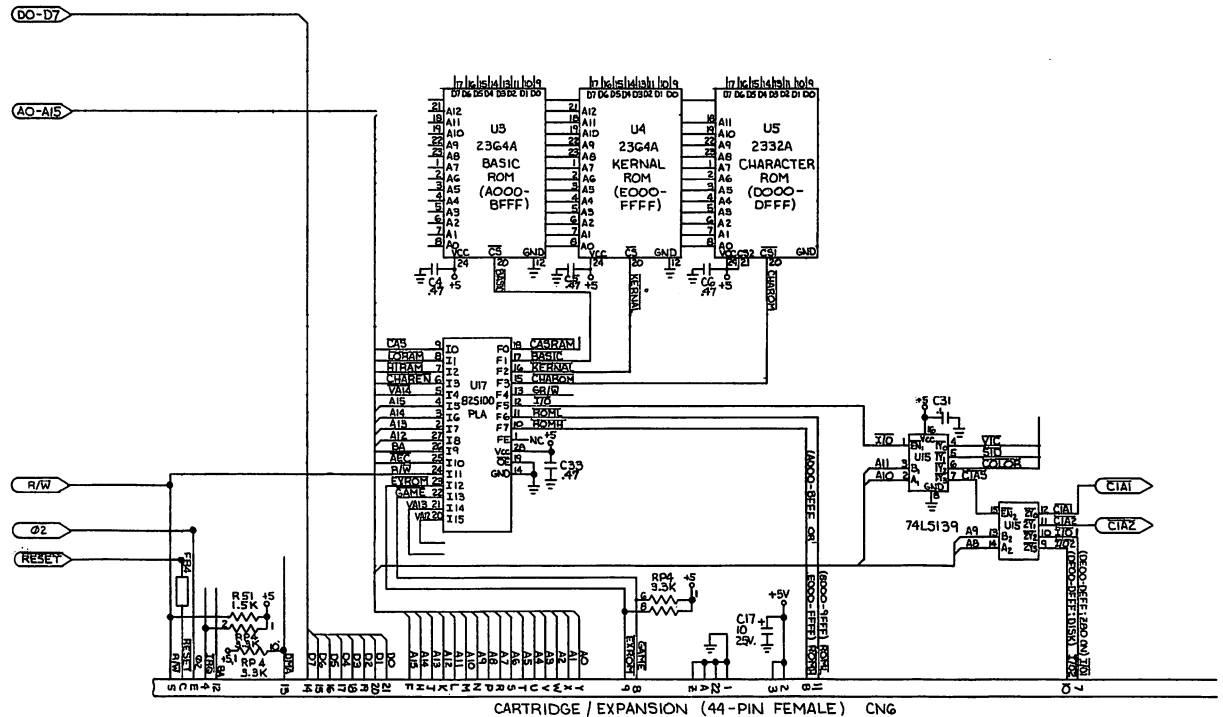
The C64 Clock Circuits.

Crystal Y1 develops a 16MHz fundamental frequency clock signal. U31 is a Dual Voltage Controlled Oscillator. The output on pin 10 is a 14.31818 MHz clock signal called the color clock. R27 can be adjusted to obtain exact output frequency. U30 is a frequency divider that outputs a 2MHz signal on pin 6. U29 is a D flip flop which outputs a 1MHz signal on pin 9. U32 is a Phase/Frequency Detector which compares the output of the U29 to the phase 0 clock, and outputs a dc voltage on pin 8 that is proportional to the phase difference between the inputs. The second half of the Dual Voltage Controlled Oscillator U31 generates an 8.1818MHz clock signal called the DOT Clock. The VIC IC divides the DOT clock by eight and outputs this as the phase 0 clock on pin 17. The output of the Phase/Frequency Detector is applied to the frequency control input pin 2 of U31. This causes tracking of the dot clock and the color clock because one input, pin 3 of U32, is the phase 0 clock which is derived from the dot clock, and the other input pin 1 of U32, is derived from the color clock.



The C64B Clock Circuits. Refer to schematic 251469

Crystal Y1 develops the fundamental 16MHz clock signal. U31 is a Clock Generator IC that outputs the 8.1818MHz DOT clock on pin 6, and the 14.31818 MHz color clock on pin 8.



I/O and ROM Address Decoding and Expansion Port.

I/O Address Decoding Logic.

U17 is a Programmable logic array (PLA). The output F5 on pin 12 called I/O goes "low" when any of the I/O devices controlled by U15 are selected. The addresses are listed below for each device.

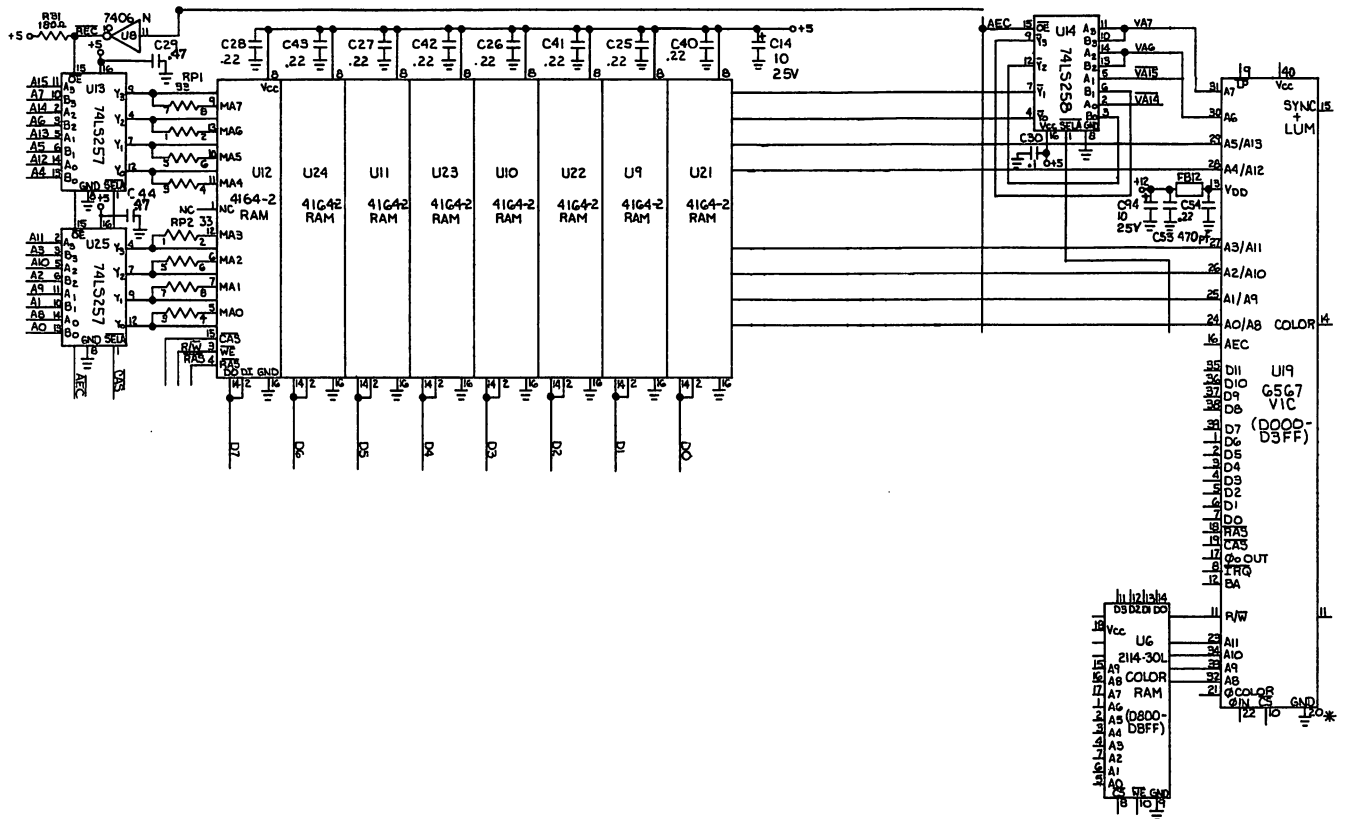
VIC IC	\$D000 - \$D02E
SID IC	\$D400 - \$D7FF
Color Ram	\$D800 - \$DBFF
CIA1	\$DC00 - \$DC0F
CIA2	\$DD00 - \$DD0F
I/O 1	\$DE00 - \$DEFF
I/O 2	\$DF00 - \$DFFF

ROM Address Decoding.

Basic ROM resides at locations \$A000 - \$BFFF. The output F1 pin 17 of the PLA U17 goes "low" when the BASIC ROM is selected. The KERNAL ROM resides at locations \$E000 - \$FFFF. The output F2 pin 16 of the PLA U17 goes "low" when the KERNAL ROM is selected. The CHARACTER GENERATOR ROM resides at locations \$D000 - \$DFFF. The output F3 pin 15 of the PLA U17 goes "low" when the Character Generator ROM is selected.

The Expansion Port Connections.

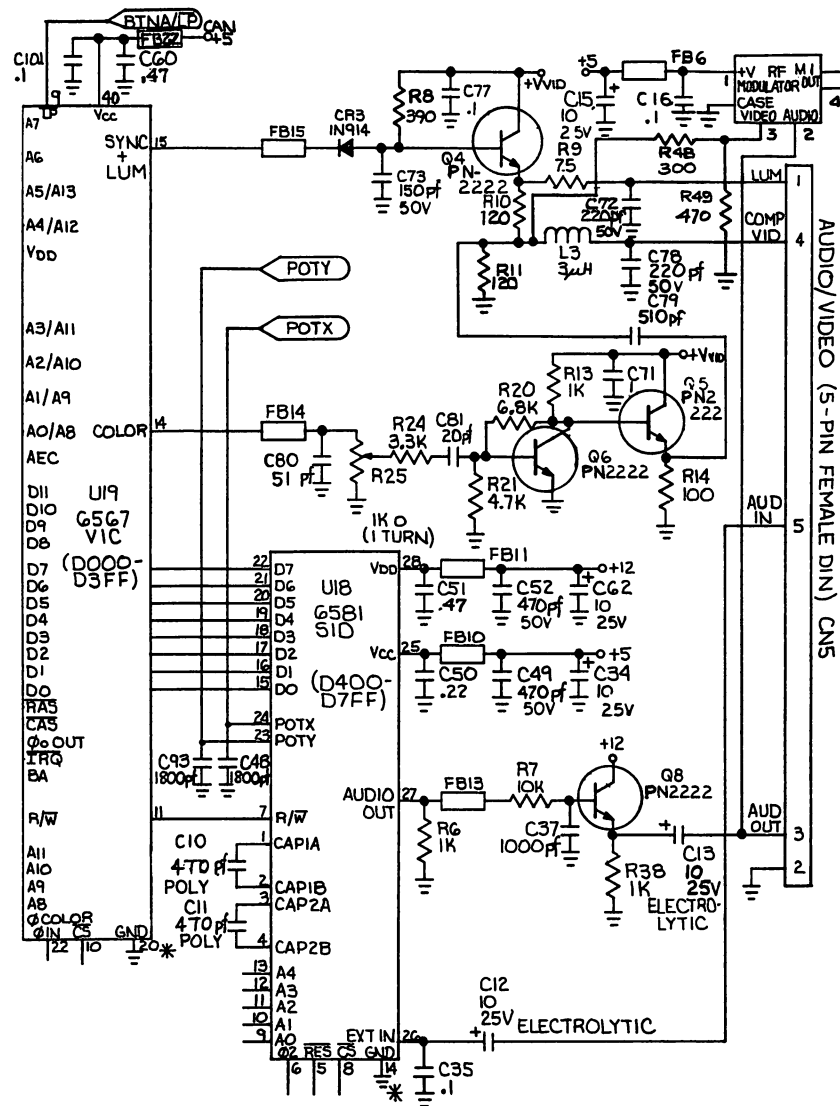
The expansion port is an extension of the microprocessor address, data, and control bus. ROML decodes addresses \$8000 - \$9FFF, and ROMH decodes addresses \$E000 - \$FFFF. These are outputs from the PLA used to select the cartridge inserted in the expansion port. I/O 1 input from U15 decodes addresses \$DE00 - \$DEFF. I/O 2 output from U15 decodes addresses \$DF00 - \$DFFF.



RAM Control Logic.

U13 and U25 are multiplexers. The address outputs from the microprocessor are passed to RAM via U13 and U25 when the output Address Enable Control (AEC) from the VIC IC is "high". When AEC is "low" the VIC IC outputs refresh addresses on pins 24 - 31. AEC goes "low" when the system clock, phase 2, is "low". Since all I/O decoding occurs when phase 2 is "high", refresh is transparent to the processor.

Eight 4164 DRAMS provide 64k bytes of memory. One 2114 RAM (U6) provides 512 bytes of memory allocated for screen color data storage.

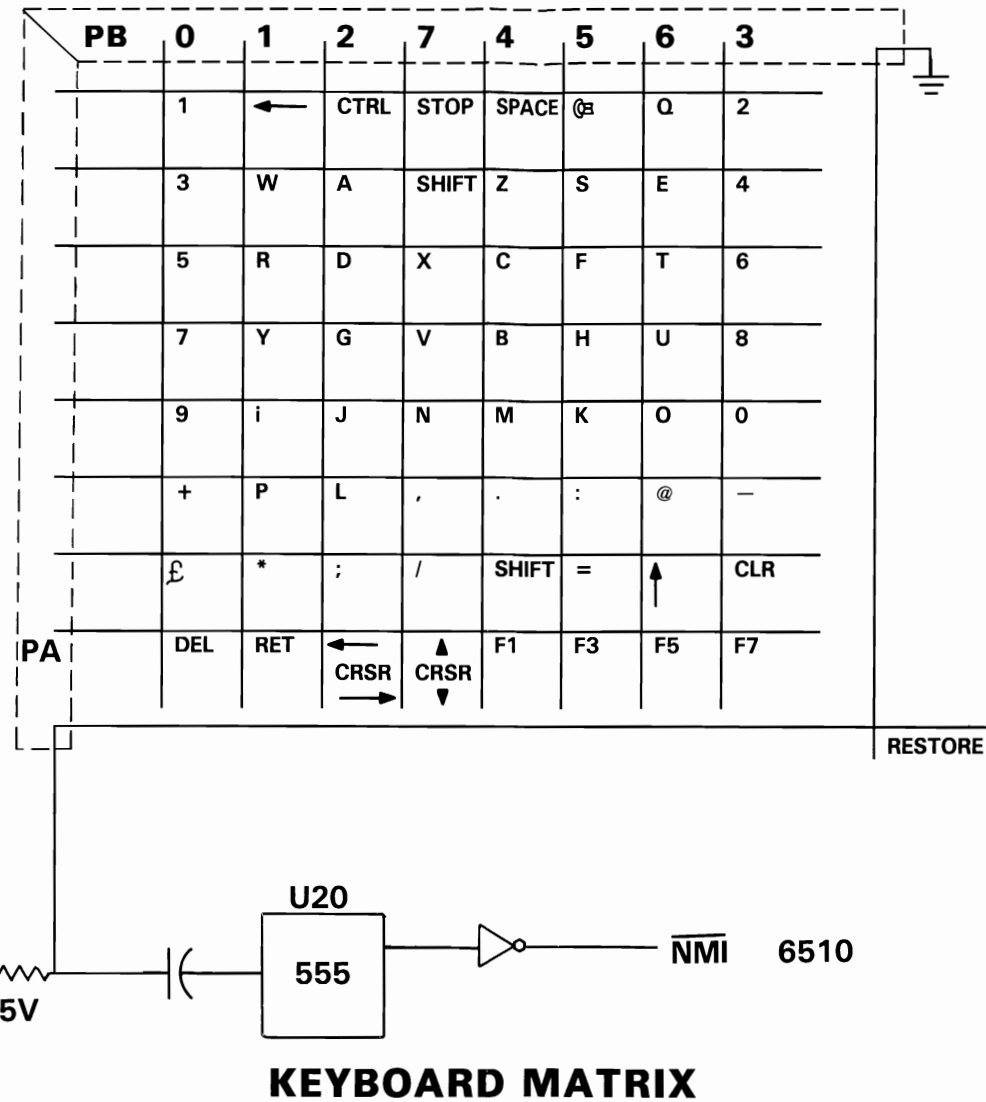
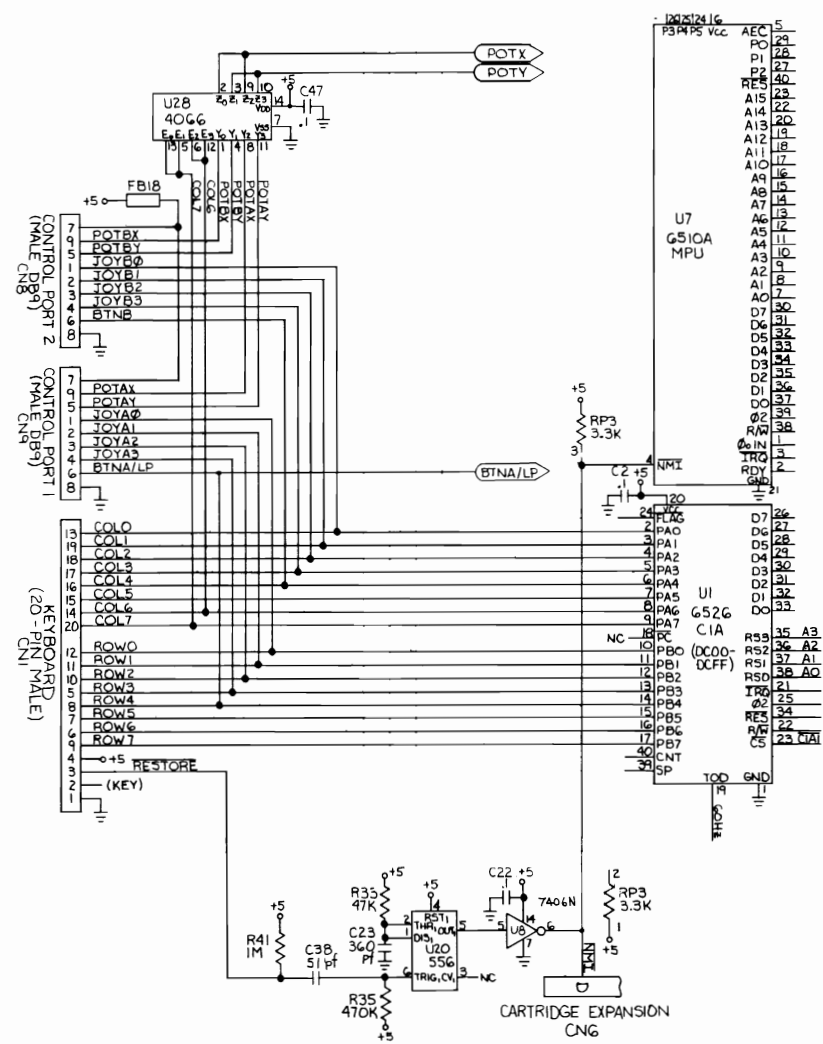


5 Pin Video and Audio Output Circuits.

Pin 15 of the VIC IC is the sync/luminance output. Pin 14 is the color output. A composite video output is created by mixing sync/luminance and color. The composite output is applied to the RF modulator, and also passed to the monitor connector CN5 on pin 4. The color output is not made available on the monitor connector CN5 as on the 8 pin version, and the RF modulator mixes audio with the composite video producing the TV RF output, unlike the 8 pin version RF modulator which creates the composite video output.

The schematic diagram illustrates the cassette interface circuit for the Commodore 64. The central component is the 6510A MPU (U7), which is connected to the cassette motor and its control logic. The MPU's pins are connected to the cassette motor's pins (CASS RD, CASS WRT, CASS SENSE, CASS WRT, CASS RD) and to the control logic. The control logic includes a 5V regulator (U1), a 6526 CIA (U2), and a 6545 PPI (U3). The PPI is used to generate the motor's control signals. The motor is connected to the cassette tape's 6-pin male edge connector (C3).

U7 is a 6510 microprocessor. One of the features of the 6510 is a built in parallel I/O port (P0-P5). P3 - P5 control most of the cassette interface circuitry. P3 pin 26 of U7 outputs the write data signal to connector CN3 on pins E and 5. P4 is an input that senses the play switch depressed on the cassette deck. P5 is an output that controls the cassette motor. When P5 goes "low", Q2 cuts off, CR2 regulates Vb of Q1 at 7.5 volts, this forward biases Q1 and Q3, passing current through the cassette motor coil. U1 is a Complex Interface Adapter (CIA). Parallel ports, serial outputs, and Timers are standard features of the CIA. Read data enters on pins D, 4 of CN3. U1 accepts the read data signal on the FLAG input pin 24.



Keyboard, Joystick, and Paddle Interface Circuits.

Keyboard Interface.

U1 is a Complex Interface Adapter (CIA). Both parallel ports are used to decode the keyswitches on the keyboard. Parallel port A signals (PA0 - PA7) are outputs. Parallel port B signals (PB0 - PB7) are inputs. A "0" bit is shifted through the parallel port A, when a key is depressed on the keyboard, the "0" bit is returned on one of the parallel port B inputs. A program in the KERNAL ROM generates the shifting "0" bit output on parallel port A, and decodes the signals returning on the parallel port B inputs. Depressing the restore key causes U20 to trigger. U8 pin 6 goes "low" generating a Non-Maskable Interrupt (NMI) at the processor. This causes the processor to execute a subroutine which initializes the I/O Interfaces. If the STOP key is depressed at the same time, BASIC flags are also initialized.

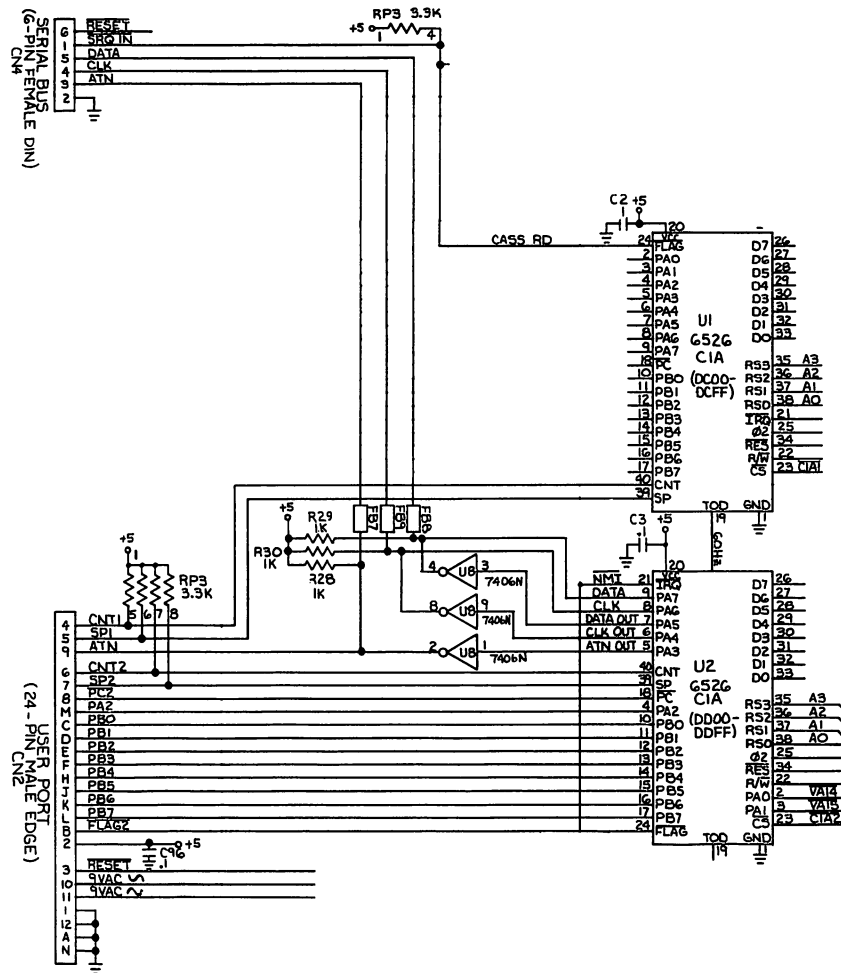
Joystick Interface.

U1 also controls the joystick. Parallel port A accepts inputs from the B joystick connected to control port 2. Parallel port B accepts inputs from the A joystick connected to control port 1. When the joystick is moved up, down, left, right, or the fire button is depressed, a ground potential is applied to the appropriate input of U1.

Paddle Interface.

A Variable resistor is connected to adjusting knob on the paddle. When the knob is rotated, the resistance varies controlling the time constant of an RC network. The Voltage developed across the capacitor is input to an A/D converter internal to the SID chip U18. The digital output is stored in one of the SID registers. The paddle position can be determined by the reading the contents of the appropriate register. U28 is a 4066 CMOS switch. The signals from the paddles are passed to the SID chip when the Enable inputs (E0 - E3) of U28 are "high".

NOTE: U1 port assignments are incorrect on schematics. Refer to Keyboard Matrix for correct assignments.



The Serial Interface and User Port Circuits.

The Serial Interface.

U2 is a Complex Interface Adapter (CIA). Parallel port signals PA3-PA7 control the serial bus interface. PA3 is the Attention (ATN) output. This signal is inverted by U8 before being transmitted to a device on the bus. PA4 is the Clock output. Data transmitted from the C64 to a device on the bus is synchronized by this clock signal. U8 inverts the output PA4. PA5 is the data output. U8 inverts this output also. Data transmitted from a device on the bus to the C64 is synchronized by a clock generated by the transmitting device. The Clock signal is input on PA6. Data transmitted from a device on the bus to the C64 is input on PA7. When a device on the bus wants to communicate with the C64, SRQ IN goes "low" indicating service is requested.

The User Port.

Parallel port B of U2 (PB0 - PB7) is made available on the user port. Parallel data transfers with external devices are made very easily through this parallel port. SP2 and SP1 are bi-directional serial ports. CNT1 and CNT2 are bi-directional synchronizing clock signals for each serial port.

64 TROUBLESHOOTING GUIDE

SYMPTOM	POSSIBLE SOLUTION
Blank screen on power up.	Check External Power Supply U4 (KERNAL ROM), U17 (PLA) U7 (6510 MPU), U3 (ROM) U8 (7406 IC), U19 (VIC II) U9-U12 (4164 RAM) U21-U24 (4164 RAM) VR2, CR4, VR1
Out of memory error on power up.	Check U9-U12 (4164 RAM) U21-U24 (4164 RAM) **** USE DIAGNOSTIC TEST — DISK
No cursor displayed. Intermittent blank screen.	Check U1, U15, U7 Check U2, U7
Powers up with graphic display and blinking cursor.	Check U14 (74LS258 IC)
Powers up with all the characters displayed as blocks.	Check U26 (74LS373 IC)
Intermittent display.	Check C88 (Possible Bad Connection)
Powers up with 'PRESS PLAY ON TAPE' message and the display blanks.	Check U7 (6510 MPU) R1 (Possible Bad Connection)
On power up the cursor locks up.	Check U7 (6510 MPU) U20 (556 IC)
When 'RETURN' is pressed after a run command, the cursor goes back to home position.	Check U3 (ROM)
Poke command does not work.	Check U3 (ROM)
Joystick does not operate correctly.	Check U1, U28 (6526 CIA)
Wrong frequency.	Check C70
No character lettering is displayed on the screen.	Check U3 (ROM) U2 (CIA)
Graphic characters instead of letters displayed.	Check U19 (VIC II)
Power up message appears but no cursor.	Check U1, U15, U7 and U4

64 TROUBLESHOOTING GUIDE (Continued)

SYMPTOM	POSSIBLE SOLUTION
Cursor jumps back to home position. Abnormal colors appear in the letters. Different characters are displayed and cursor is locked when turned on and off. System does not reset and the 'RESTORE' key does not work. White band scrolls down the screen. (60 HZ HUM) Cursor disappears after the system warms up. SYNTAX ERROR displayed after system warms up. Wavy screen after the system warms up. The system resets when it warms up and long programs do not load. Keyboard does not operate correctly when the system warms up. Black band scrolls through screen when system warms up. Cassette motor keeps running. Cassette motor keeps running even after a program is done loading. The TIP 29 transistor gets extremely hot and the fuse may possibly blow. The cursor disappears when the cassette is plugged in. Cassette runs extremely slow. The program seems to load but will not run.	Check U7 (6510 MPU) Check U6 (2114 RAM) U16 (4066 IC) Check RAM Check U20 (556 IC) Check External Power Supply VR2 (5V Regulator) Check U1 (6526 CIA) Check RAM, U3 (ROM) Check External Power Supply U31 (74LS629 IC) U30 (74LS193 IC) Check U7 (6510 MPU) U3 (ROM) Check U1 (6526 CIA) U3 (ROM) Check External Power Supply C90, C88, CR4 VR2 (5V Regulator) Check U7 (6510 MPU) Check Cassette Port for Shorts R4 (Possibly Open) Check U7 (6510 MPU) Check U7 (6510 MPU)

64 TROUBLESHOOTING GUIDE (Continued)

SYMPTOM	POSSIBLE SOLUTION
When loading from a cassette, the 'SYNTAX ERROR' message is displayed.	Check U20 (556 IC)
DEVICE NOT PRESENT ERROR is displayed when disk is used.	Check U1 (6526 CIA) U7 (6510 MPU) R28, R29, R30
Disk drives continue to search when trying to load.	Check U2 (6526 CIA)
When loading from disk and any key of the 4th row of the keyboard is pressed, the cursor goes to home position.	Check U20 (556 IC) R35 (Possible Bad Connection)
When loading from disk, a 'FILE NOT FOUND' message is displayed.	Check U4 (ROM) U2 (6526 CIA)
OUT OF MEMORY ERROR is displayed when disk is used.	Check U20 (556 IC)

C64 BOARD IDENTIFICATION

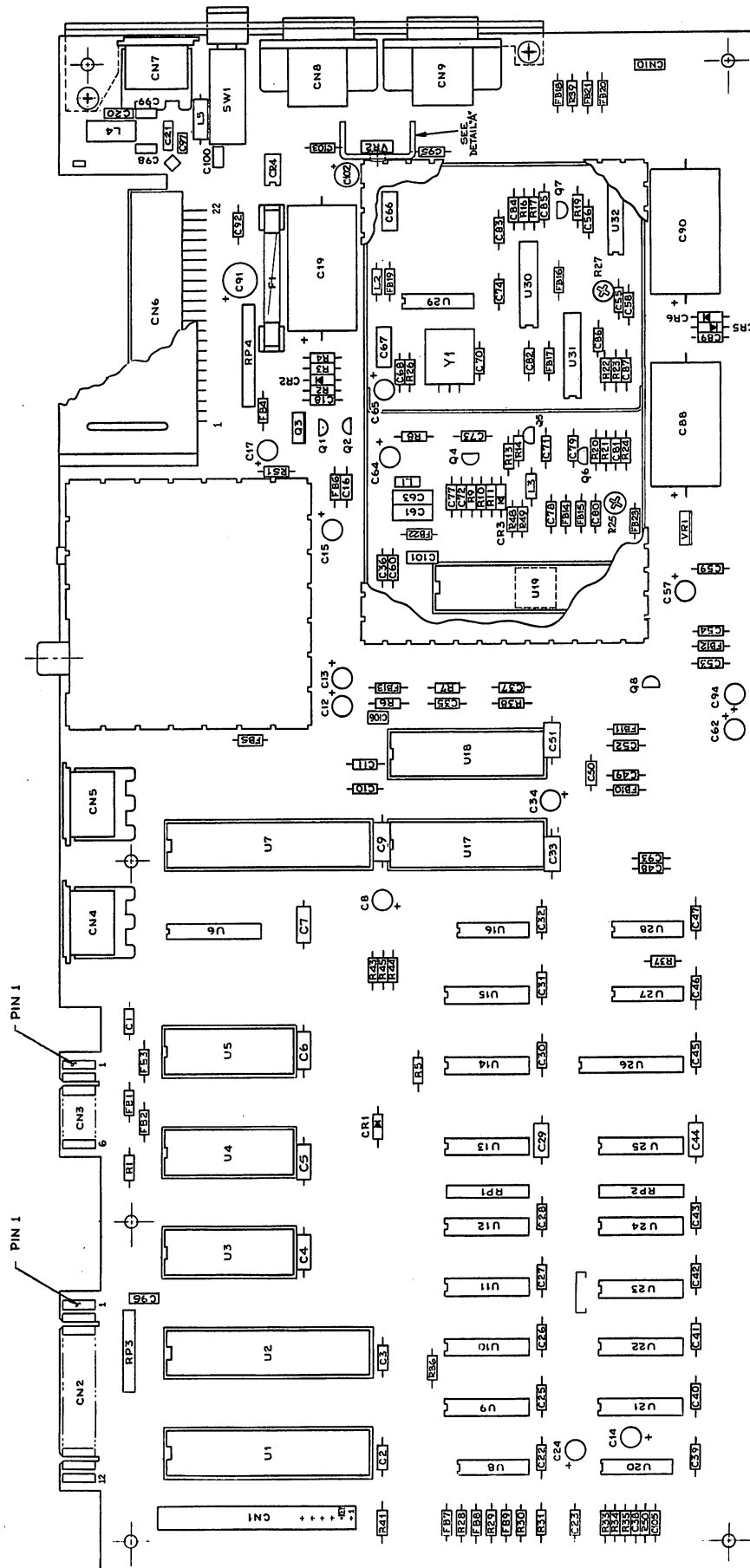
To date there are 4 versions of 64 PCB assemblies in use.

VERSION	IDENTIFYING FACTORS	PCB ASSY #	SCHEMATIC #
Original	5 pin board (CN5-Video port has 5 pins)	326298-01	326106
A (CR)	8 pin board (CN5-Video port has 8 pins)	250407-04	251138
B	8 pin board (Reduced oscillator circuit)	250425	251469
B-2	8 pin board (Reduced Osc. w/component changes)	250441-01 *	251469

- These boards are interchangeable with casework, keyboard, etc.; however, care must be taken to provide the customer with a unit that is compatible with their monitor and cable.
- When component level repairs are necessary, be certain to acquire the appropriate part for the board you are repairing. Most modulators are different, as are many of the other components.

*The 4th version of 64 board was recently developed and only a few may be in the field. It is termed the 64B-2. All circuits remain the same as the 64B (Schematic 251469) with a few component location changes:

- 1) Resistors 28, 29, 30, 36, 48 were reduced to Resistor Pack RP5.
- 2) Diodes CR100-105 are no longer piggybacked. Their new locations are CR9, 12-16.



BOARD LAYOUT #326298-01

PARTS LIST — PCB ASSEMBLY # 326298

C — Indicates Commodore Stocked Part Numbers

INTEGRATED CIRCUITS			
U1,U2	6526 CIA	C 906108-01	
U3	2364 Basic ROM	C 901226-01	
U4	2364 Kernal ROM	C 901227-03	
U5	2332 Char ROM	C 901225-01	
U6	2114L-30 RAM	901453-01	
U7	6510 μ Processor	C 906107-01	
U8	7406	901522-06	
U9-U12	4164 (200 nS)	901505-01	
U13	74LS257	901521-57	
U14	74LS258	901521-58	
U15	74LS139	901521-18	
U16	4066	901502-01	
U17	82S100 PLA	C 906114-01	
U18	6581 SID	C 906112-01	
U19	6567 VIC II	C 906109-01	
U20	LM556	901523-03	
U21-U24	4164 (200 nS)	901505-01	
U25	74LS257	901521-57	
U26	74LS373	901521-29	
U27	74LS08	901521-03	
U28	4066	901502-01	
U29	74LS74	901521-06	
U30	74LS193	901521-26	
U31	74LS629	901521-68	
U32	MC4044	906128-01	
TRANSISTORS			
Q1	2N4401	902652-01	
Q2	2N3904	902658-01	
Q3	TIP29 B	902653-01	
Q4-8	2N2222	902686-01	
DIODES			
CR1	2.7V Zener IN4371		
CR2	7.5V Zener IN755		
CR3	IN914		
CR4	Bridge, Varo VM08	906129-01	
CR5,6	Rectifier IN4001		
RESISTORS — All values are in ohms- 1/4 W, 5%, unless noted otherwise.			
R1	3.3K	R7	10K
R2	1.5K	R8	390
R3	10K	R9	75
R4	1K	R10	120
R5	560	R11	120
R6	1K	R13	1K

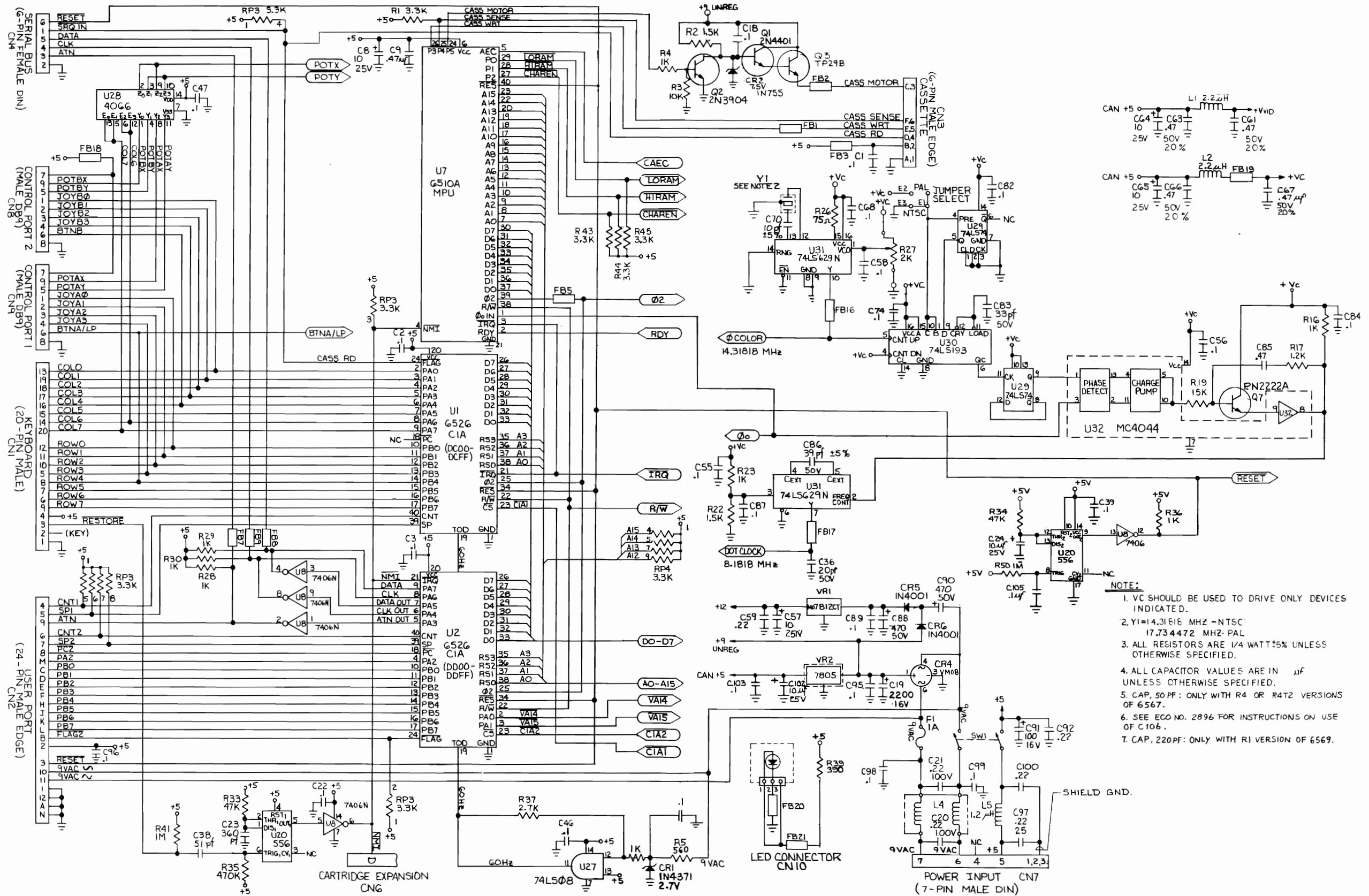
RESISTORS (Continued)			
R14	100	R30	1K
R16	1K	R31	180
R17	1.2K	R33	47K
R19	15K	R34	47K
R20	6.8K	R35	470K
R21	4.7K	R37	2.7K
R22	1.5K	R38	1K
R23	1K	R39	390
R24	3.3K	R41	1M
R25	Pot 1K	R43	3.3K
R26	75	R44	3.3K
R27	Pot 2K	R45	3.3K
R28	1K	R46	2K
R29	1K	R51	1.5K
NOTE: The input video line requires a 470 ohm, 1/4 watt, resistor soldered to ground.			
RESISTOR PACKS			
RP1,2	33 Ω , 8 Pin (Bourns No. 4308R-102-330)		
RP3	3.3K Ω , 8 Pin (Bourns No. 4308R-101-332)		
RP4	3.3K Ω , 10 Pin		
CAPACITORS			
C1-3	Ceramic	.1 μ F, 50V	
C4-7	Ceramic	.47 μ F, 50V, 20%	
C8	Electrolytic	10 μ F, 25V, + 50%, - 10%	
C9	Ceramic	.47 μ F, 50V, 20%	
C10,11	Ceramic	470 pF, 50V	
C12-15	Electrolytic	10 μ F, 25V, + 50%, - 10%	
C16	Ceramic	.1 μ F, 50V	
C17	Electrolytic	10 μ F, 25V, + 50%, - 10%	
C18	Ceramic	.1 μ F, 50V	
C19	Electrolytic	2200 μ F, 16V	
C20,21	Film	.22 μ F, 100V, 20%	
C22	Ceramic	.1 μ F, 50V	
C23	Ceramic	360 pF, 50V	
C24	Electrolytic	10 μ F, 25V, + 50%, - 10%	
C25-28	Ceramic	.22 μ F, 50V	
C29	Ceramic	.47 μ F, 50V, 20%	
C30,31,32	Ceramic	.1 μ F, 50V	
C33	Ceramic	.47 μ F, 50V, 20%	
C34	Electrolytic	10 μ F, 25V, + 50%, - 10%	
C35	Ceramic	.1 μ F, 50V	
C36	Ceramic	20 pF, 50V	
C37	Ceramic	1000 pF, 50V	

PARTS LIST — PCB ASSEMBLY # 326298 (Continued)

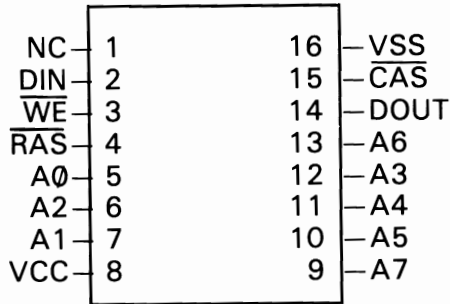
C — Indicates Commodore Stocked Part Numbers

CAPACITORS (Continued)			CAPACITORS (Continued)		
C38	Ceramic	51 pF, 50V	C94	Electrolytic	10 μ F, 25V, + 50%, - 10%
C39	Ceramic	.1 μ F, 50V	C95,96	Ceramic	.1 μ F, 50V
C40-43	Ceramic	.22 μ F, 50V	C97	Ceramic	.22 μ F, 25V
C44	Ceramic	.47 μ F, 50V, 20%	C98,99	Ceramic	.1 μ F, 50V, 20%
C45,46,47	Ceramic	.1 μ F, 50V	C100	Ceramic	.22 μ F, 25V
C48	Ceramic	1800 pF, 50V	C101	Ceramic	.1 μ F, 50V, 20%
C49	Ceramic	470 pF, 50V	C102	Electrolytic	10 μ F, 25V, + 50%, - 10%
C50	Ceramic	.22 μ F, 50V	C103	Ceramic	.1 μ F, 50V
C51	Ceramic	.47 μ F, 50V, 20%	C105	Ceramic	.1 μ F, 50V
C52,53	Ceramic	470 pF, 50V	CONNECTORS		
C54	Ceramic	.22 μ F, 50V	CN1	Header Assy, 20 Pin	903331-20
C55	Ceramic	.1 μ F, 50V	CN4	6 Pin Din	C 903361-01
C56	Ceramic	.1 μ F, 50V	CN5	5 Pin Din	C 903362-01
C57	Electrolytic	10 μ F, 25V, + 50%, - 10%	CN6	44 Pin Card Edge	C 906100-02
C58	Ceramic	.1 μ F, 50V	CN7	7 Pin Din	C 906130-01
C59	Ceramic	.22 μ F, 50V	CN8,9	Plug Assy, 9 Pin Rt. Angle	C 906126-01
C60,61	Ceramic	.47 μ F, 50V, 20%	CN10	Header Assy, 3 Pin	
C62	Electrolytic	10 μ F, 25V, + 50%, - 10%	MISCELLANEOUS		
C63	Ceramic	.47 μ F, 50V, 20%	L1,2	Coil Inductor 2.2 μ H	901151-17
C64,65	Electrolytic	10 μ F, 25V, + 50%, - 10%	L3	Coil Inductor 3.0 μ H	901151-21
C66,67	Ceramic	.47 μ F, 50V, 20%	L4	Line Filter Assy	C 906127-01
C68	Ceramic	.1 μ F, 50V	L5	Coil Inductor 1.2 μ H	901152-01
C69			Y1	Crystal 14.31818 MHz	C 900558-01
C70	Mica	10 pF, 500V, 5%	SW1	Rocker Switch DPDT	C 904500-01
C71	Ceramic	.1 μ F, 50V	VR1	Voltage Regulator MC7812CT	901527-01
C72	Ceramic	220 pF, 50V	VR2	Voltage Regulator MC7805CT	901527-02
C73	Ceramic	150 pF, 50V	M1	Modulator	C 326130-01
C74	Ceramic	.1 μ F, 50V	F1	Fuse, Normal Blo, 250V, 1.5A	
C77	Ceramic	.1 μ F, 50V	FB1-23	Ferrite Bead	903025-01
C78	Ceramic	220 pF, 50V		Connector Panel (ON, OFF, Joystick)	326299-01
C79	Ceramic	510 pF, 50V		Cartridge Guide	326116-01
C80	Ceramic	51 pF, 50V		Shield Box	C 326265-01
C81	Ceramic	20 pF, 50V		Shield Cap	C 326267-01
C82	Ceramic	.1 μ F, 50V			
C83	Mica	33 pF, 500V, 5%			
C84	Ceramic	.1 μ F, 50V			
C85	Ceramic	.47 μ F, 50V, 20%			
C86	Mica	39 pF, 500V, 5%			
C87	Ceramic	.1 μ F, 50V			
C88	Electrolytic	470 μ F, 50V			
C89	Ceramic	.1 μ F, 50V			
C90	Electrolytic	470 μ F, 50V			
C91	Electrolytic	100 μ F, 16V			
C92	Ceramic	.22 μ F, 50V			
C93	Ceramic	1800 pF, 50V			

SCHEMATIC #326106 SHEET 1 OF 2

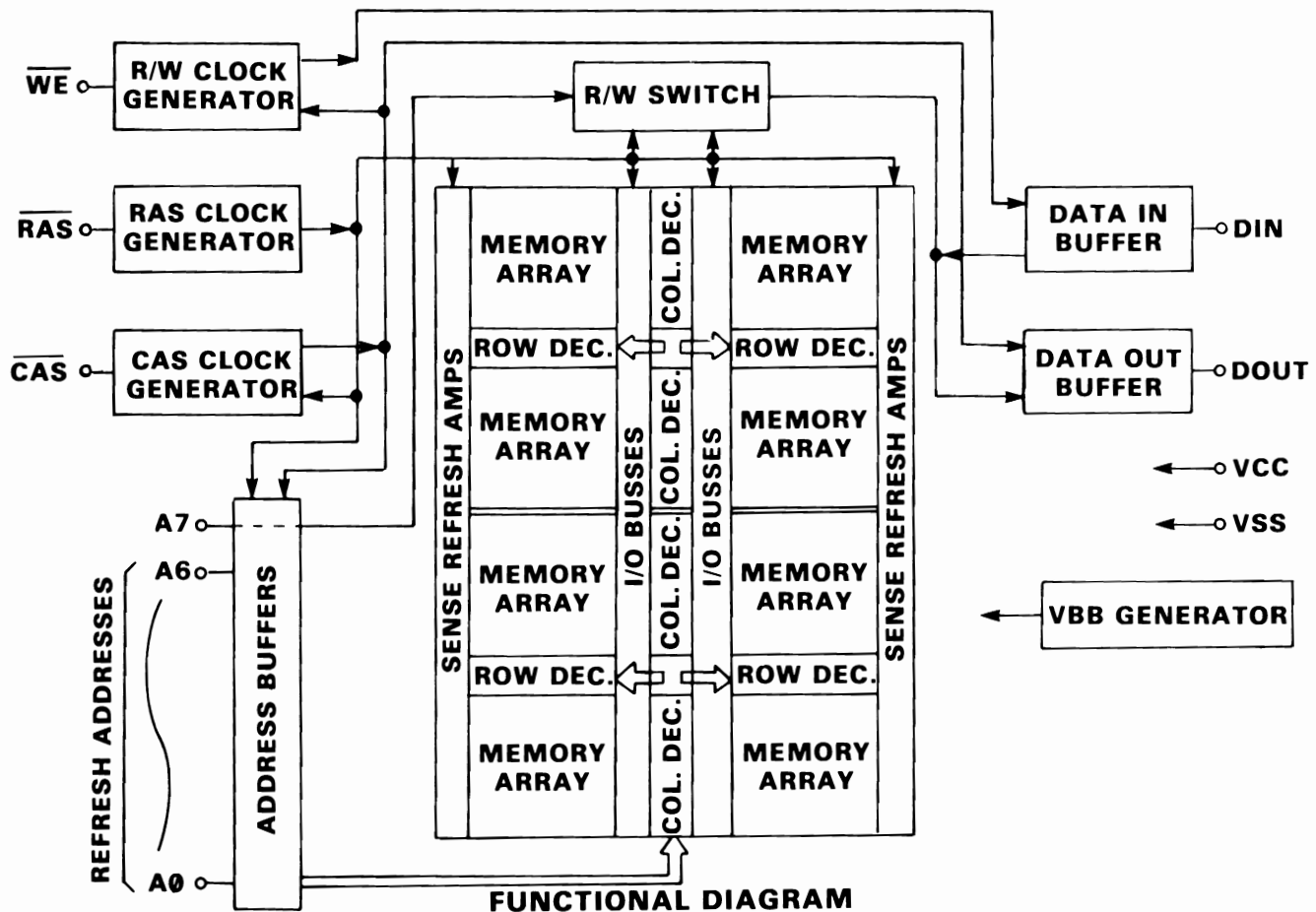


PIN CONFIGURATION

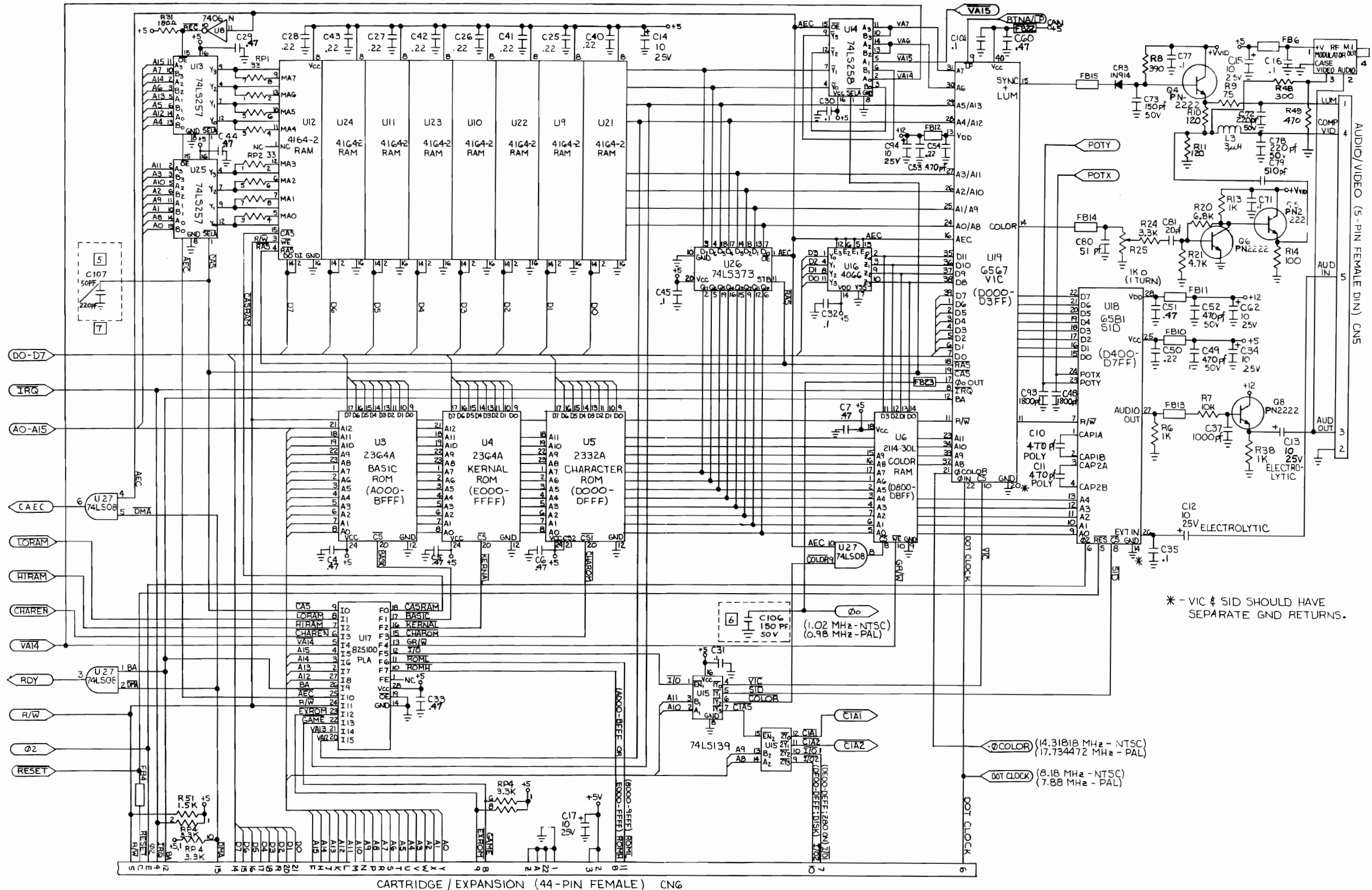


U9 ~ 12, U21 ~ 24
 64K DYNAMIC RAM
 901505-01

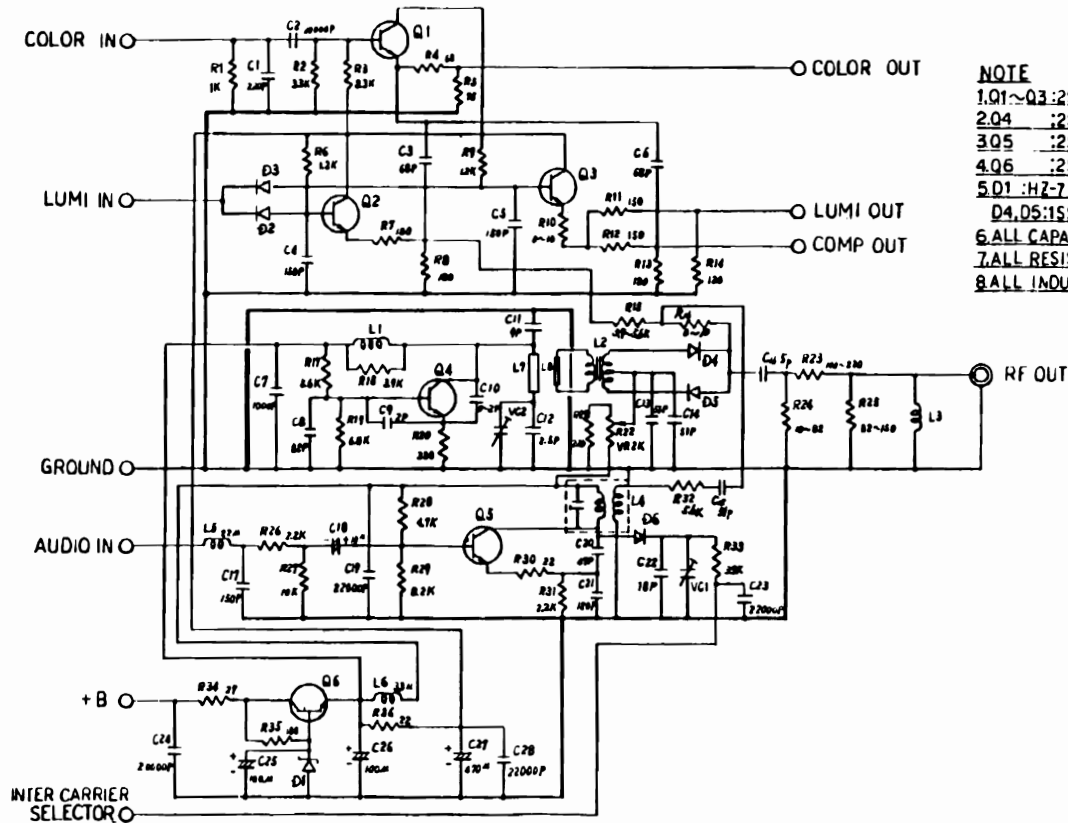
COMMODORE PART NUMBER	APPROVED SOURCE 1 OF SUPPLY	VENDOR PART NUMBER	ACCESS TIME (ns)	CYCLES (ns)	POWER	
					ACTIVE (MW)	STANDBY (MAX)(MW)
901505-01	HITACHI	HM4864-3	200	335	330	20
901505-01	NEC	μ PD4164-2	200	375	250	28
901505-01	MITSUBISHI	M5K416NS-20	200	330	275	28
901505-01	MOSTEK	MK4564N-20	200	345	300	22
901505-01	OKI	MSM3764-20	200	330	248	23
901505-01	HITACHI	HM4864P-3	200	335	330	20
901505-01	MATSUSHITA (PANASONIC)	MN4164P-20	200	330	275	27.5
901505-01	SIEMENS	HYB4164-3	200	330	150	20
901505-01	SHARP	LH2164-Z1	200	330	248	28
901505-01	HITACHI	HM4864AP-3	200	330	242	20
901505-01	TOSHIBA	TMM4164AP-20	200	330	275	22



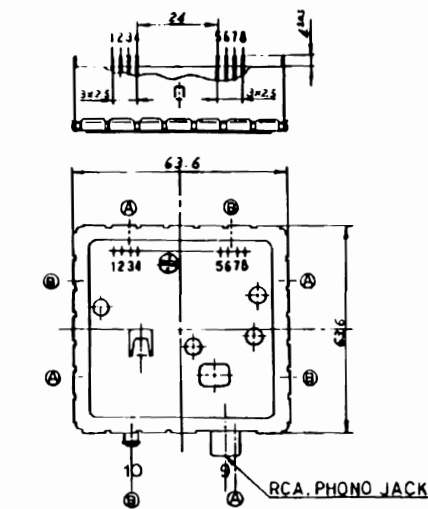
SCHEMATIC #326106 SHEET 2 OF 2



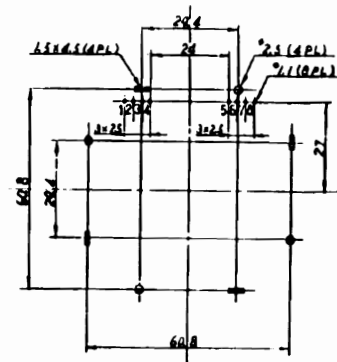
MODULATOR SCHEMATIC #251025



NOTE
 1.Q1-Q3:2SC1684 OR EQUIVALENT
 2.Q4 :2SC1730 OR EQUIVALENT
 3.Q5 :2SC460 OR EQUIVALENT
 4.Q6 :2SC2120 OR EQUIVALENT
 5.D1 :HZ-7 D2,D3:1SS119
 D4,D5:1SS86 OR 1SS174 D6:1SS110
 6.ALL CAPACITANCE VALUES :F
 7.ALL RESISTANCE VALUES :Ω
 8.ALL INDUCTANCE VALUES :H



NO	TERMINALS
1	+B
2	SYNC+LUM SIG.INPUT
3	COLOR SIG.INPUT
4	AUDIO SIG.INPUT
5	COMP. SIG.OUTPUT
6	SYNC+LUM SIG.OUTPUT
7	COLOR SIG.OUTPUT
8	INTERCARRIER SELECTOR
9	RF OUTPUT
10	CHANNEL TRIMMER



NOTE
 1.RECOMMENDED P.C.B. HOLE CENTERS
 (COMPONENT SIDE)
 2.ALL DIMENSION ARE IN MILLIMETERS
 3.NO.8 TERMINAL SHORT=G.PAL
 OPEN = L.PAL



PARTS LIST — PCB ASSEMBLY # 250407-04
C — Indicates Commodore Stocked Part Number

INTEGRATED CIRCUITS			
U1,U2	6526 CIA	C 906108-01	
U3	2364 Basic ROM	C 901226-01	
U4	2364 Kernal ROM	C 901227-03	
U5	2332 Char ROM	C 901225-01	
U6	2114L-20 RAM	901453-01	
U7	6510 μ Processor	C 906107-01	
U8	7406	901522-06 sub:	
	7416	901522-14	
U9-U12	4164 (200 nS)	901505-01	
U13	74LS257	901521-57	
U14	74LS258	901521-58	
U15	74LS139	901521-18	
U16	4066	901502-01	
U17	82S100 PLA	C 906114-01	
U18	6581 SID	C 906112-01	
U19	6567 VIC II	C 906109-01	
U20	LM556	901523-03	
U21-U24	4164 (200 nS)	901505-01	
U25	74LS257	901521-57	
U26	74LS373	901521-29	
U27	74LS08	901521-03	
U28	4066	901502-01	
U29	74LS74	901521-06	
U30	74LS193	901521-26	
U31	74LS629	901521-68	
U32	MC4044	906128-01	
TRANSISTORS			
Q1,2	2SC1815	C 902693-01 sub:	
Q3	TIP29 A	902653-01	
Q7,8	2SC1815	C 902693-01	
DIODES			
CR1	2.7V Zener IN4371	906103-02	
CR2	7.5V Zener IN755	900941-01	
CR4	Bridge S2VB10 3D	C 251026-01	
	DBA20B	C 251026-02	
	DBA20C	C 251026-03	
CR5,6	Rectifier IN4001	900750-01	
RESISTORS — All values are in ohms- 1/4 W, 5%, unless noted otherwise.			
R1	3.3K	R6	1K
R2	1.5K	RR7	10K
R3	10K	R16	1K
R4	1K	R17	2.7K
R5	560	R19	15K

RESISTORS (Continued)			
R26	Jumper Wire	R39	390
R27	Pot 500 Ω	R41	1M
R28	1K	R42	82
R29	1K	R43	3.3K
R30	1K	R44	3.3K
R31	180	R45	3.3K
R33	47K	R50	1M
R34	47K	R51	1.5K
R35	470K	R52	300
R36	1K	R53	390
R37	2.7K	R100	1K
R38	1K	R101	22K
RESISTOR PACKS			
RP1,2	33 Ω , 8 Pin (Bourns No. 4308R-102-330)		
RP3	3.3K Ω , 8 Pin (Bourns No. 4308R-101-332)		
RP4	3.3K Ω , 10 Pin		
CAPACITORS			
C1-7	Ceramic	.1 μ F, 25V	
C8	Electrolytic	10 μ F, 25V, + 50%, - 10%	
C9	Ceramic	.1 μ F, 25V	
C10,11	Ceramic	470 pF, 50V, 10%	
C12	Ceramic	.1 μ F, 25V	
C13,14,15	Electrolytic	10 μ F, 25V, + 50%, - 10%	
C16	Ceramic	.1 μ F, 25V	
C17	Electrolytic	10 μ F, 25V, + 50%, - 10%	
C18	Ceramic	.1 μ F, 25V	
C19	Electrolytic	2200 μ F, 16V	
C20,21	Film	.22 μ F, 100V, 20%	
C22	Ceramic	.1 μ F, 25V	
C23	Ceramic	360 pF, 50V, 10%	
C24	Electrolytic	10 μ F, 25V, + 50%, - 10%	
C25-33	Ceramic	.1 μ F, 25V	
C34	Electrolytic	10 μ F, 25V, + 50%, - 10%	
C35	Ceramic	.1 μ F, 50V	
C36	Ceramic	20 pF, 50V, 5% SL	
C37	Ceramic	1000 pF, 50V, 10% B	
C38	Ceramic	51 pF, 50V, 5% SL	
C39-47	Ceramic	.1 μ F, 25V	
C48	Ceramic	1800 pF, 50V, 10% B	
C49-54	Ceramic	.1 μ F, 25V	
C55	Ceramic	.1 μ F, 50V	
C56	Ceramic	.1 μ F, 25V	
C57	Electrolytic	10 μ F, 25V, + 50%, - 10%	
C58	Ceramic	.1 μ F, 50V	

PARTS LIST — PCB ASSEMBLY #250407-04 (Continued)

C — Indicates Commodore Stocked Part Number

CAPACITORS (Continued)			CONNECTORS		
C59,60	Ceramic	.1 μ F, 25V	CN1	Header Assy, 20 Pin	903331-20
C62,65	Electrolytic	10 μ F, 25V, +50%, -10%	CN4	6 Pin Din	C 903361-01
C66,67,68	Ceramic	.1 μ F, 25V	CN5	8 Pin Din	C 325573-01
C70	Film	16 pF, 5%	CN6	44 Pin Card Edge	C 906100-02
C74,82	Ceramic	.1 μ F, 25V	CN7	7 Pin Din	C 251116-01
C83	Ceramic	82 pF, 5%	CN8,9	Plug Assy, 9 Pin MINID	C 906126-01
C84	Ceramic	.1 μ F, 25V	CN10	Header Assy, 3 Pin	903332-03
C85	Ceramic	.47 μ F, 50V, 10%	MISCELLANEOUS		
C88	Electrolytic	1000 μ F, 25V	L2	Coil Inductor 2.2 μ H	901151-17
C89	Ceramic	.1 μ F, 25V	L4	Coil Inductor 1.2 μ H	325570-01
C90	Electrolytic	470 μ F, 50V	L5	Choke Coil	C 325559-02
C91	Electrolytic	100 μ F, 16V, +50%, -10%	Y1	Crystal 14.31818 MHz	C 900558-01
C92	Ceramic	.1 μ F, 25V	SW1	Rocker Switch DPDT	904500-01
C93	Ceramic	1800 pF, 50V, 10% B	VR1	Voltage Regulator MC7812CT	901527-01
C94	Electrolytic	10 μ F, 25V, +50%, -10%	VR2	Voltage Regulator MC7805CT	901527-02
C95,96	Ceramic	.1 μ F, 25V	M1	Modulator	C 251080-01
C97	Ceramic	.22 μ F, 25V	F1	Fuse, Normal Blo, 250V, 1.5A	
C98,99	Ceramic	.1 μ F, 50V, +80%, -20%	FB1-5	Ferrite Bead	903025-01
C100	Ceramic	.22 μ F, 25V	FB7-23	Connector Panel (Power, ON, OFF)	251095-01
C101	Ceramic	.1 μ F, 50V, +80%, -20%		Cartridge Guide	326116-01
C102	Electrolytic	10 μ F, 25V, +50%, -10%		Shield Box	C 251023-01
C103	Ceramic	.1 μ F, 25V		Shield Cap	C 251024-01
C104					
C105	Ceramic	.1 μ F, 25V			
C108	Electrolytic	10 μ F, 25V, 20%			
C200	Ceramic	.1 μ F, 25V			

U1, U2 — 906108-01
6526 COMPLEX INTERFACE
ADAPTER (CIA)

**PIN
ASSIGNMENT**

GND	1	40	CNT
PA0	2	39	SP
PA1	3	38	RS0
PA2	4	37	RS1
PA3	5	36	RS2
PA4	6	35	RS3
PA5	7	34	$\overline{RES}$
PA6	8	33	DB0
PA7	9	32	DB1
PB0	10	31	DB2
PB1	11	30	DB3
PB2	12	29	DB4
PB3	13	28	DB5
PB4	14	27	DB6
PB5	15	26	DB7
PB6	16	25	$\overline{Q2}$
PB7	17	24	$\overline{FLAG}$
$\overline{PC}$	18	23	$\overline{CS}$
TOD	19	22	$\overline{R/W}$
VCC	20	21	$\overline{IRQ}$

1	VSS	Ground Connection.
2-9	PA0-PA7	Parallel port a signals. Bidirectional parallel port.
10-17	PB0-PB7	Parallel port b signals. Bidirectional parallel port.
18	PC	Handshake output. A low pulse is generated after a read or write on port b.
19	TOD	Time of day clock input. Programmable 50hz or 60hz input.
20	VCC	5VDC input.
21	IRQ	Interrupt output to microprocessor input IRQ.
22	R/W	READ/WRITE input from microprocessor's R/W output.
23	CS	Chip select input. A low pulse will activate CIA.
24	FLAG	Negative edge sensitive interrupt input. Can be used as a handshake line for either parallel port.
25	$\overline{Q2}$	$\overline{Q2}$ clock input. Connected to processor common $\overline{Q2}$ clock.
26-33	DB0-DB7	Bidirectional data bus. Connects to processor data bus.
34	RES	Low active reset input. Initializes CIA.
35-38	RS0-RS3	Register select inputs. Used to select all internal registers for communications with the parallel ports, time of day clock, and serial port (SP).
39	SP	Serial Port bidirectional connection. An internal shift register converts microprocessor parallel data into serial data, and visa-versa.
40	CNT	Count input. Internal timers can count pulses applied to this input. Can be used for frequency dependent operations.

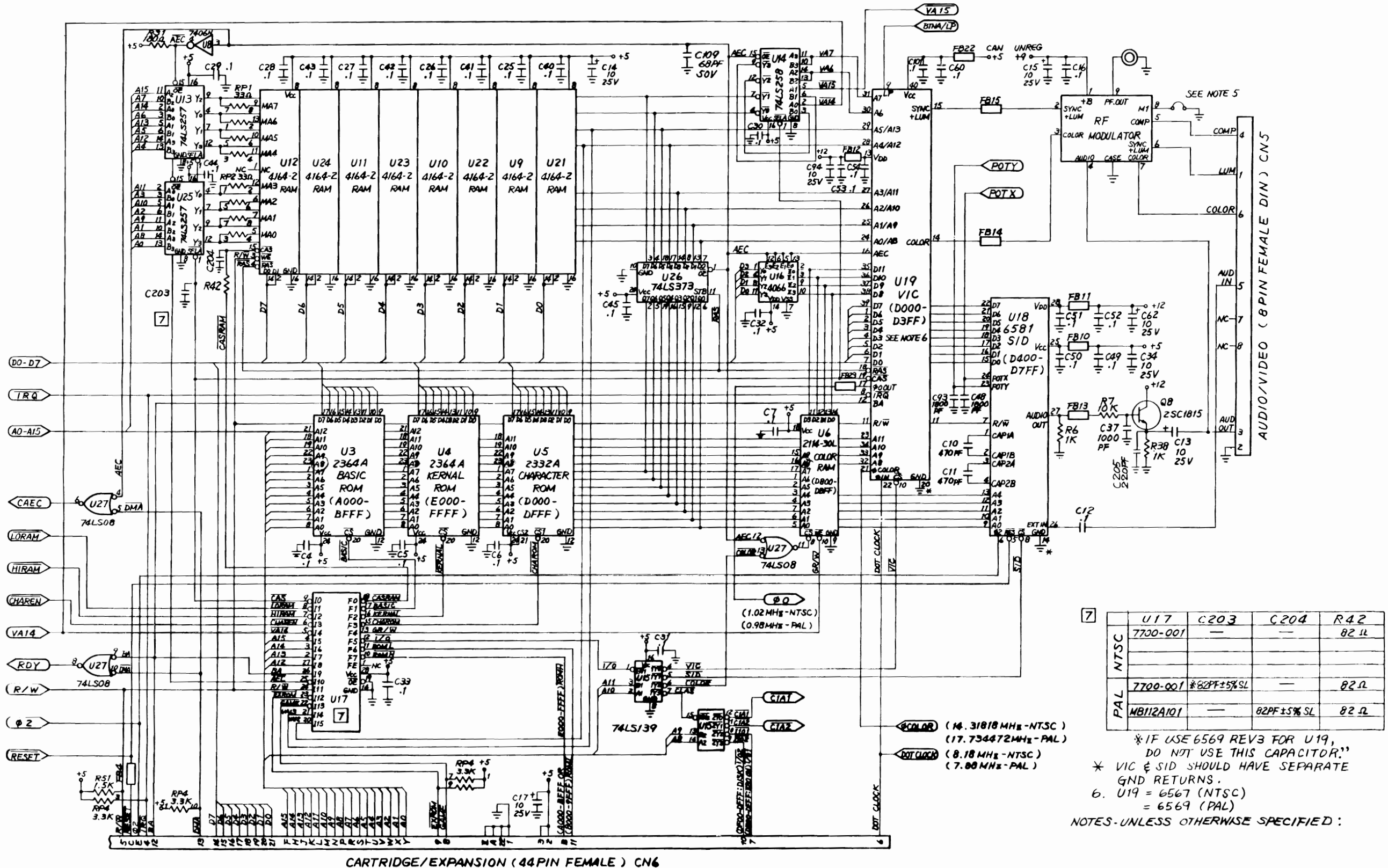
U18 — 906112-01
6581 SOUND INTERFACE
DEVICE (SID)

**PIN
ASSIGNMENT**

CAP	1A	28	12V
CAP	1B	27	A.OUT
CAP	2A	26	EXT IN
CAP	2B	25	5V
RES	5	24	POT X
$\overline{Q2}$	6	23	POT Y
$\overline{R/W}$	7	22	D7
$\overline{CS}$	8	21	D6
A0	9	20	D5
A1	10	19	D4
A2	11	18	D3
A3	12	17	D2
A4	13	16	D1
GND	14	15	D0

1,2,3,4	CAP1A,1B	Capacitor filter connections.
5	2A, 2B	
5	RES	Reset input. A low pulse initializes the SID.
6	$\overline{Q2}$	Processor phase 2 clock input.
7	R/W	Processor read/write input.
8	CS	Chip select input.
9-13	A0-A4	Address lines from processor.
14	GND	Dc ground connection.
15-22	D0-D7	Data Bus connections.
23	POT Y	Input to a A/D converter used to detect the value of a variable resistor. Commonly connected to game paddles.
24	POT X	Same as POT Y.
25	VCC	5VDC.
26	EXT IN	External audio input.
27	Audio out	Audio output. Should be AC coupled to audio amp.
28	Vdd	12VDC.

SCHEMATIC #251138 SHEET 1 OF 2



**U7 — 906107-01
6510 MICROPROCESSOR**

**PIN
ASSIGNMENT**

Q1	1	40	RES
RDY	2	39	Q2
IRQ	3	38	R/W
NMI	4	37	DB0
AEC	5	36	DB1
VCC	6	35	DB2
A0	7	34	DB3
A1	8	33	DB4
A2	9	32	DB5
A3	10	31	DB6
A4	11	30	DB7
A5	12	29	P0
A6	13	28	P1
A7	14	27	P2
A8	15	26	P3
A9	16	25	P4
A10	17	24	P5
A11	18	23	A15
A12	19	22	A14
A13	20	21	GND

**PIN
ASSIGNMENT**

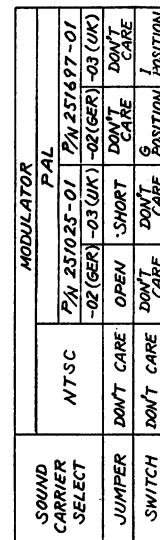
PE +	1	28	VCC
I7	2	27	I8
I6	3	26	I9
I5	4	25	I10
I4	5	24	I11
I3	6	23	I12
I2	7	22	I13
I1	8	21	I14
I0	9	20	I15
F7	10	19	CE
F6	11	18	F0
F5	12	17	F1
F4	13	16	F2
GND	14	15	F3

**U17 — 906114-01
PROGRAMMABLE
LOGIC ARRAY (PLA)**

1	01	Phase 1 clock input. This clock input is used to develop the internal overlapping phase 2 clock. 1 MegHz or 2 MegHz speeds.
2	RDY	Single step operation input. A low applied will cause the processor to halt. The current address line being fetched will be on the address bus. Can also be used to interface slower devices to the microprocessor.
3	IRQ	Interrupt request input. When a low pulse is applied a jump to a location specified by the contents of FFFE and FFFF will occur to service the interrupt, if the interrupt mask flag is not set. This is a maskable interrupt.
4	NMI	Non-maskable interrupt input. A low transition will cause a jump to a location specified by FFFA and FFFB to a subroutine which will service the interrupt.
5	AEC	Address enable control input. A low applied to will cause the address bus to enter hi impedance state, so other devices can control the address bus.
6	VCC	5VDC input.
7-20	A0-A15	Address bus outputs. Unidirectional bus used to address memory and I/O devices. The address bus can be disabled by controlling the AEC input.
21	GND	Dc ground connection.
24-29	P0-P5	I/O bidirectional port. This port can be controlled via memory locations 0000 and 0001. 0001 = Output register 0000 = Data direction register
30-37	DB0-DB7	Bidirectional data bus. This is the bus that passes the data to or from any I/O device or memory.
38	R/W	Read/Write output. The processor generates a low level when writing, and a high level when reading. This signal is usually decoded for read or write operations to memory or I/O.
39	02	Phase 2 output. The processor generates this clock signal from the phase 1 clock applied. The two clock signals are 180 degrees out of phase. The phase 2 clock is used in decoding I/O and memory on the positive half cycle.
40	RES	Reset input interrupt. A low pulse causes a jump to a subroutine specified by FFFC and FFFD, which will initialize all processor controlled devices. This occurs during a power up sequence.

USER PORT
(24 - PIN MALE EDGE)
CN2





DETAIL "C" SOUND CARRIER SELECT

BOARD LAYOUT #250425-01

PARTS LIST — PCB ASSEMBLY #250425-01

C — Indicates Commodore Stocked Part Number

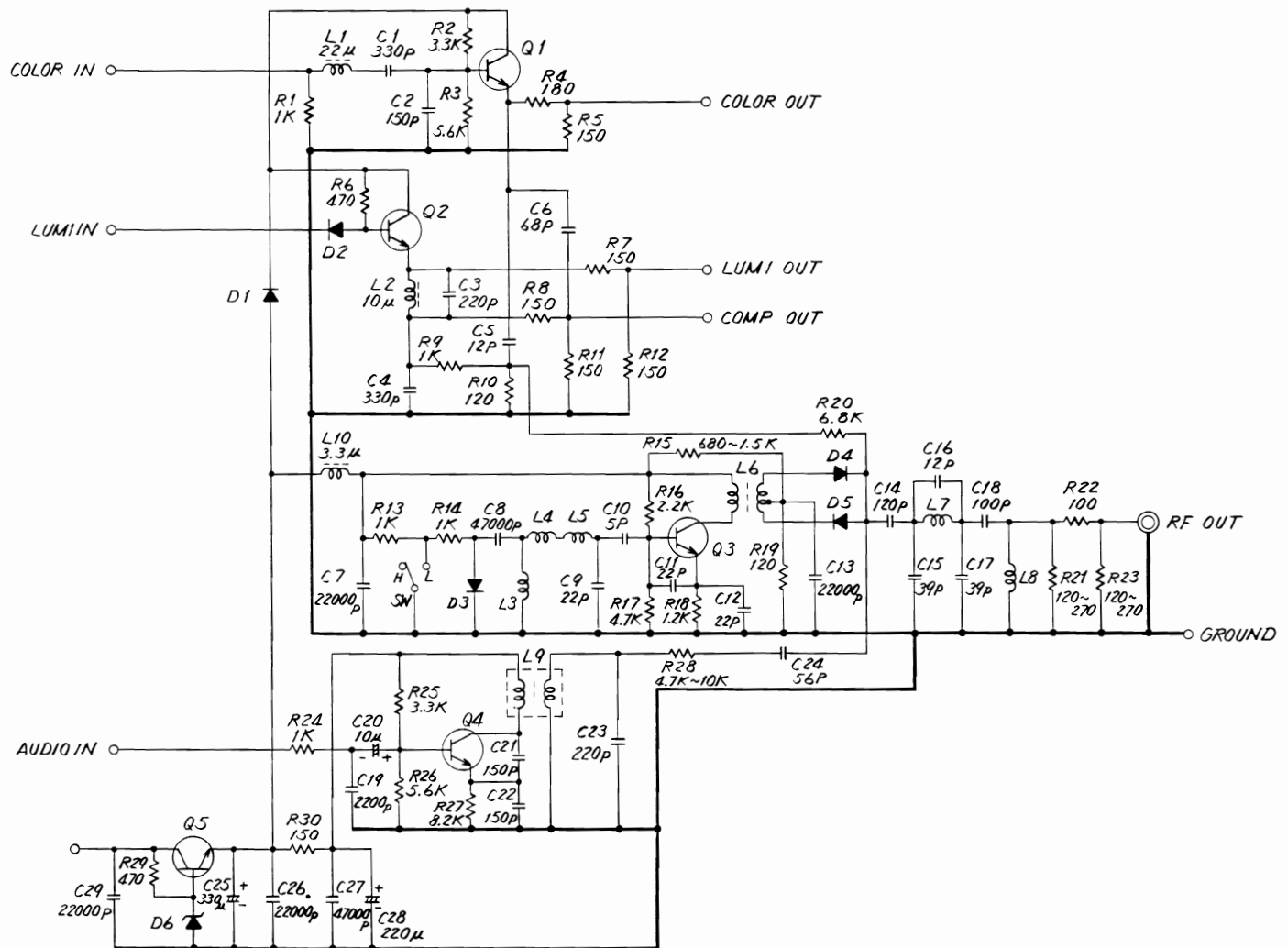
INTEGRATED CIRCUITS				RESISTORS (Continued)			
U1,U2	6526 CIA	C 906108-01		R39	390	R50	1M
U3	2364 Basic ROM	C 901226-01		R41	1M	R51	1.5K
U4	2364 Kernal ROM	C 901227-03		R42	82	R60	100
U5	2332 Char ROM	C 901225-01		R43	3.3K	R100	1K
U6	2114L-20 RAM	901453-01		R44	3.3K	R101	22K
U7	6510 μ Processor	C 906107-01		R45	3.3K		
U8	7406	901522-06 sub:		RESISTOR PACKS			
	7416	901522-14		RP1,2	33 Ω , 8 Pin (Bourns No. 4308R-102-330)		
U9-U12	4164 (200 nS)	901505-01		RP3	3.3K Ω , 8 Pin (Bourns No. 4308R-101-332)		
U13	74LS257	901521-57		RP4	3.3K Ω , 10 Pin, 1/4 W		
U14	74LS258	901521-58		RP5	1K Ω , 6 Pin		
U15	74LS139	901521-18		CAPACITORS			
U16	4066	901502-01		C1-7	Ceramic .1 μ F, 25V		
U17	82S100 PLA	C 906114-01		C9	Ceramic .1 μ F, 25V		
U18	6581 SID	C 906112-01		C10,11	Ceramic 470 pF, 50V, 10%		
U19	6567 VIC II	C 906109-01		C12	Ceramic .1 μ F, 25V		
U20	LM556	901523-03		C13	Electrolytic 10 μ F, 25V, +50%, -10%		
U21-U24	4164 (200 nS)	901505-01		C15	Tantalum 4.7 μ F, 16V, 20%		
U25	74LS257	901521-57		C19	Electrolytic 2200 μ F, 16V		
U26	74LS373	901521-29		C20	Film .22 μ F, 100V, 20%		
U27	74LS08	901521-03		C22	Ceramic .1 μ F, 25V		
U28	4066	901502-01		C23	Ceramic 360 pF, 50V, 10% sub:		
U31	7701/8701	C 251527-01			390 pF		
TRANSISTORS				C24	Electrolytic 22 μ F, 25V, +50%, -10%		
Q1	TIP29 A	902653-01		C31,33,34	Ceramic .1 μ F, 25V		
Q2-4	2SC1815	C 902693-01		C37	Ceramic 1000 pF, 50V, 10% B		
DIODES				C38	Ceramic 51 pF, 50V, 5% SL		
CR1	2.7V Zener IN4371	906103-02		C39-46	Ceramic .1 μ F, 25V		
CR2	6.8V Zener IN754A			C48	Ceramic 1800 pF, 50V, 10% B		
CR4	Bridge S2VB10	C 251026-01 sub:		C50,51,53	Ceramic .1 μ F, 25V		
	DBA20B	C 251026-02 sub:		C59	Ceramic .1 μ F, 25V		
	DBA20C	C 251026-03		C88	Electrolytic 1000 μ F, 25V		
CR5,6	Rectifier IN4001	900750-01		C90	Electrolytic 470 μ F, 50V		
CR9,	IN4148 sub:			C91	Electrolytic 100 μ F, 16V, +50%, -10%		
CR12-16,	IN914			C93	Ceramic 1800 pF, 50V, 10% B		
100-105				C101	Ceramic .1 μ F, 50V, +80%, -20%		
RESISTORS — All values are in ohms- 1/4 W, 5%, unless noted otherwise.				C102	Ceramic .1 μ F, 25V		
R1	3.3K	R26	3.3K	C150-152	Ceramic 470 pF, 50V, 10%		
R2	470	R31	180	C153	Ceramic 68 pF, 50V, 5%		
R3	100K	R33	47K	C154	Ceramic 470 pF, 50V, 10%		
R4	1K	R34	47K	C200	Ceramic .1 μ F, 25V		
R5	560	R35	470K	C204	Ceramic 150 pF, 50V, 10%		
R6	1K	R37	2.7K	C205	Ceramic 220 pF, 50V, 5%		
R7	10K	R38	1K	CT1	Trimmer 40 pF		

PARTS LIST — PCB ASSEMBLY # 250425-01 (Continued)

C — Indicates Commodore Stocked Part Number

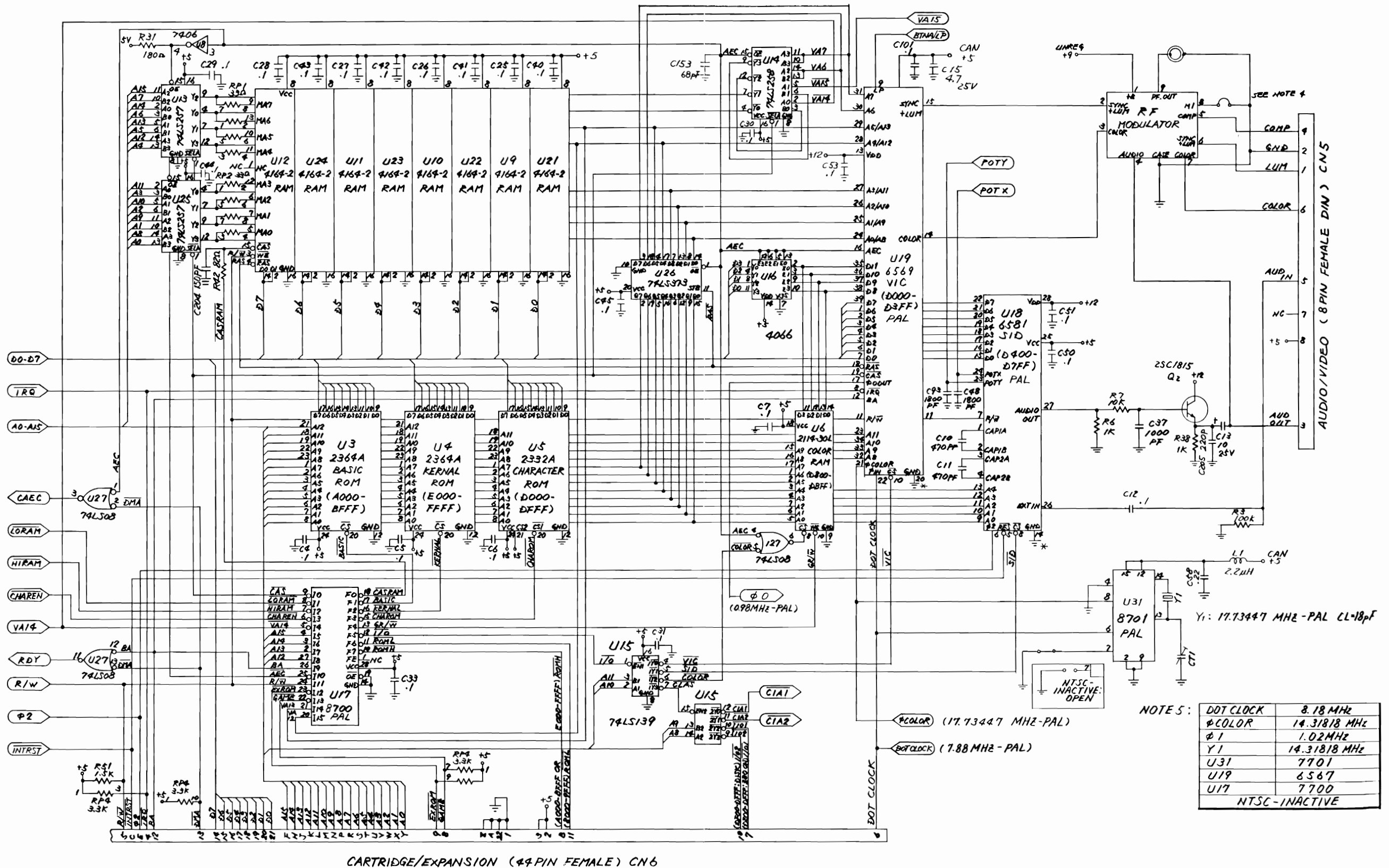
CONNECTORS			MISCELLANEOUS (Continued)		
CN1	Header Assy, 20 Pin	903331-20	SW1	Rocker Switch DPDT	904500-01
CN4	6 Pin Din	C 903361-01	VR1	Voltage Regulator MC7812CT	901527-01
CN5	8 Pin Din	C 325573-01	VR2	Voltage Regulator MC7805CT	901527-02
CN6	44 Pin Card Edge	C 906100-02			
CN7	7 Pin Din	C 251116-01			
CN8,9	Plug Assy, 9 Pin MINID	C 251057-01			
CN10	Header Assy, 3 Pin	903332-03	M1	Modulator	C 251696-01
MISCELLANEOUS				Connector Panel (Power, ON, OFF)	251095-01
L1	Coil Inductor 2.2 μ H	901151-17		Cartridge Guide	326116-01
L4	Line Filter Assy	C 251701-01			
L5	Coil Inductor 1.2 μ H	901152-01			
Y1	Crystal 14.31818 MHz	C 251467-01	F1	Fuse, Normal Blo, 250V, 1.5A	

MODULATOR SCHEMATIC #251696



NOTES

1. D1, D2 : MA151K OR EQUIVALENT
2. D3 : MA57 OR EQUIVALENT
3. D4, D5 : 1SS198 OR EQUIVALENT
4. D6 : HZ-7A1 OR EQUIVALENT
5. Q1, Q2 : 2SC2405 OR EQUIVALENT
6. Q3, Q4 : 2SC2778 OR EQUIVALENT
7. Q5 : 2SC2120Y OR EQUIVALENT
8. COMPONENT PARTS VALUE : R= Ω , C=F, L=H



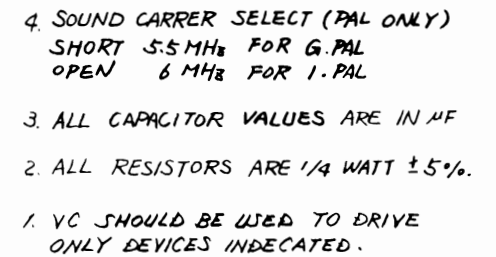
PIN ASSIGNMENT

DB6	1	40	VCC
DB5	2	39	DB7
DB4	3	38	DB8
DB3	4	37	DB9
DB2	5	36	DB10
DB1	6	35	DB11
DB0	7	34	A10
IRQ	8	33	A9
LP	9	32	A8
CS	10	31	A7
R/W	11	30	A6("1")
BA	12	29	A5(A13)
VDD	13	28	A4(A12)
COLOR	14	27	A3(A11)
SYNC/LUM	15	26	A2(A10)
AEC	16	25	A1(A9)
PHO	17	24	A0(A8)
RAS	18	23	A11
CAS	19	22	PHIN
VSS	20	21	PHCL

U19 — 906109-01 MULTIPLEXED ADDRESSES IN PARENTHESES

1-7/39	DB0-DB7	Processor data bus connections. Bidirectional data.
8	IRQ	Interrupt output. Generates a interrupt signal to the processor indicating service is needed. The light pen input can be acknowledged thru use of this interrupt.
10	CS	Chip select input. A low signal selects the VIC 11.
11	R/W	Processor read/write connection.
12	BA	Bus available output. A low pulse output indicates the VIC 11 chip wants controls of the processor network to process faster video operations that the system clock can handle.
13	VDD	12VDC input.
14	COLOR	Output contains chrominance, color reference burst, and color of display data.
15	SYNC/LUM	Output containing video, horizontal and vertical sync, and luminance information.
16	AEC	Address enable output. This is usually connected to the processor AEC input, controlling the address bus. AEC = 0 processor address bus disabled, refresh ram. AEC = 1 processor address bus enabled. This allows transparent refresh operations.
17	PH0	Phase 0 output. Generated from the phase in signal.
18	RAS	Row address strobe output. Selects proper row when addressing dynamic ram for read/write operations or refresh.
19	CAS	Column address strobe output. Selects proper column when addressing dynamic memory for read or write operation.
20	VSS	Ground connection.
21	PHCL	Color clock, 14.31818 MHZ NTSC.
22	PHIN	Clock input. Determines the dot transfer rate to the display.
23-24	A0-A13	Dual function address bus. During a micro-processor read or write operation (AEC = 1), A0 thru A5 are inputs used to address 47 internal registers. When AEC = 0 = 02 is low, then A0 thru A13 are outputs used to refresh dynamic memory.
35-38	D8-D11	Data bus extension. Color display memory data.
	A8-A11	Address bus extension. Color display memory addressing.
40	VCC	5VDC input.

USER PORT (24-PIN MALE EDGE)	KEYBOARD (20-PIN MALE)	CONTROL PORT1 (MALE DB9)	CONTROL PORT2 (MALE DB9)	SERIAL BUS (6-PIN FEMALE DIN)
CN2	CN1	CN9	CN8	CN4



32



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